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STATE OF SOUTH CAROLINA

(Caption of Case)
In the Matter of:

Application of Duke Energy Carolinas, LLC for Approval of Rider 3

BEFORE THE
PUBLIC SERVICE COMMISSION
OF SOUTH CAROLINA

COVER SHEET

DOCKET
NUMBER: 2011 - 420 - E

(Please type or print)

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DOCKETING INFORMATION (Check all that apply)

☐ Emergency Relief demanded in petition ☐ Request for item to be placed on Commission's Agenda expeditiously

☒ Other: Duke Energy Carolinas, LLC's Responses to PSCSC's February 15, 2012 Directive

INDUSTRY (Check one)	NATURE OF ACTION (Check all that apply)		
☒ Electric	☐ Affidavit	☐ Letter	☐ Request
☐ Electric/Gas	☐ Agreement	☐ Memorandum	☐ Request for Certification
☐ Electric/Telecommunications	☐ Answer	☐ Motion	☐ Request for Investigation
☐ Electric/Water	☐ Appellate Review	☐ Objection	☐ Resale Agreement
☐ Electric/Water/Telecom.	☐ Application	☐ Petition	☐ Resale Amendment
☐ Electric/Water/Sewer	☐ Brief	☐ Petition for Reconsideration	☐ Reservation Letter
☐ Gas	☐ Certificate	☐ Petition for Rulemaking	☒ Response
☐ Railroad	☐ Comments	☐ Petition for Rule to Show Cause	☐ Response to Discovery
☐ Sewer	☐ Complaint	☐ Petition to Intervene	☐ Return to Petition
☐ Telecommunications	☐ Consent Order	☐ Petition to Intervene Out of Time	☐ Stipulation
☐ Transportation	☐ Discovery	☐ Prefiled Testimony	☐ Subpoena
☐ Water	☐ Exhibit	☐ Promotion	☐ Tariff
☐ Water/Sewer	☐ Expedited Consideration	☐ Proposed Order	☐ Other:
☐ Administrative Matter	☐ Interconnection Agreement	☐ Protest	
☐ Other:	☐ Interconnection Amendment	☐ Publisher's Affidavit	
	☐ Late-Filed Exhibit	☐ Report	

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March 29, 2012

Ms. Jocelyn G. Boyd
Chief Clerk & Administrator
Public Service Commission of South Carolina
101 Executive Center Drive, Suite 100
Columbia, SC 29210

RE: Application of Duke Energy Carolinas, LLC for Approval of Rider 3
Docket No. 2011-420-E

Dear Ms. Boyd:

On February 15, 2012, the Public Service Commission of South Carolina ("the Commission") issued a Directive with conditions and questions for Duke Energy Carolinas, LLC ("Duke Energy Carolinas" or "the Company") and questions for the South Carolina Office of Regulatory Staff ("ORS") to address. Listed below are Duke Energy Carolinas' responses to the Commission's conditions and questions:

Responses to Conditions:

3. As we have required of other Companies offering energy efficiency programs, the Company shall file with the Commission all EM&V results, reports, or other documentation upon completion of the studies.

   RESPONSE: Please see Ossege Exhibits A- Q and Ossege Exhibit 1 as attached.

4. As recommended by the environmental intervenors and agreed to by ORS, the Company shall provide a clear timeline – both past and future – for applying EM&V results to program energy savings estimates for the true-up, including the start, end, and effective dates of the EM&V reports. The Company shall file this timeline with the Commission by March 30, 2012.

   RESPONSE: Please see Ossege Exhibit 2 as attached.

5. As recommended by the environmental intervenors and agreed to by ORS, the Company shall file a schedule for the Company's annual save-a-watt rider proceeding that: (1) allows no less than 90 days from the date of the Company's Application until the effective date of the rider, (2) includes a deadline for Petitions to Intervene that expires 30 days after the Company's filing date, and (3) requires ORS and other intervenors to comment on the Company's Application no later than 45 days after the Company's filing date. This schedule shall be filed with the Commission by March 30, 2012.

RESPONSE:

Proposed Timeline for Future EE Rider Filings:

- Rider filing date: not later than August 1
- Deadline for intervenor petitions: not later than 30 days after August 1 filing
- Deadline for ORS and intervenors to file comments: not later than 45 days after August 1 filing.

Responses to Questions:

1. Please describe the entities involved in performing EM&V functions for the Company, both internal and third-party. *(Company and ORS)*

   RESPONSE: As described in Dick Stevie's direct testimony before the Commission in Docket No. 2007-358-E, Duke Energy Carolinas has provided for the independent review and evaluation of the Energy Efficiency ("EE") programs by an independent evaluation firm, TecMarket Works. TecMarket Works is an Oregon, Wisconsin (Madison area) program evaluation and market research firm serving utilities, energy companies and government organizations. The firm's founder, Nick Hall, has more than 30 years experience conducting energy program products and services evaluations and market assessments and in conveying the results of program research to policy makers and service designers. In addition, TecMarket Works has led or is currently conducting on behalf of regulatory staff or utilities, evaluation efforts in over 10 other states. TecMarket Works was also selected as the master evaluation contractor in the competitively bid third party evaluation for the Indiana Statewide Core Programs.

   Internally, Ashlie Ossege of Duke Energy Carolinas is the primary liaison to the EM&V contractor, with additional support from the Market Analytics group. Ms. Ossege is the Manager of Market Analytics, supporting energy efficiency ("EE") analytics. In addition, Ms. Ossege also supports the collection of market research data and analysis, marketing design testing, energy load analysis, EE cost effectiveness analysis, and product design research. She has also represented the Company at various national EM&V and energy consortiums and provided testimony on EM&V in several of the Company's jurisdictions. She has primary responsibility for coordinating and dispersing the research results obtained by the independent evaluator, TecMarket Works.

   As the third party evaluator, TecMarket Works is responsible for determining the frequency, scope, and appropriate researchable issues for the evaluation of the programs in the portfolio. This also includes selection of appropriate methodologies governing sample selection and methods used for impact evaluation. The TecMarket Works team also conducts process evaluations on the Company's DSM programs and reviews the methodologies and analyses conducted by Duke Energy Carolinas load researchers to ensure that impact calculations are consistent with accepted evaluation procedures. This is consistent with the approach presented in the direct testimony of Nick Hall of TecMarket Works and Dick Stevie of Duke Energy Carolinas in Docket No. 2007-358-E.

2. Please identify the independent third party consultant hired by ORS to provide independent oversight of the save-a-watt program. Additionally, please describe the activities and resulting conclusions of this oversight mechanism. Please explain how the Commission will be informed of the results of the consultant's reviews. *(ORS)*

   RESPONSE: No response required of Duke Energy Carolinas.

3. Please describe how the EM&V activities led by the Company interact with the independent oversight provided by the ORS independent consultant. Does responsibility for the EM&V activities and results, as required in the Settlement Agreement, lie with the Company, ORS, or both? Please explain. *(Company and ORS)*

   RESPONSE: Consistent with the terms of Save-a-Watt, the Company has contracted with a nationally recognized expert, TecMarket Works, to provide an independent third-party evaluation of the programs as further discussed in response to Question 1. While the Company provides the funds to support TecMarket Works' EM&V studies and ultimately applies the results of the EM&V, the sole responsibility for providing EM&V results that will be applied in the determination of actual program results lies with TecMarket Works.

4. The Company stated in its application at Paragraph 17 that this mid-term true-up "incorporates the most recent available EM&V results." The environmental comments stated on page 4 that "this application does not have any EM&V applied to it." Please explain. *(Company and ORS)*

   RESPONSE: The Company originally filed Rider 3 on October 20, 2011. On December 20, 2011, the Company made a revised filing to correct several scrivener errors made in the initial application. All changes were non-substantive. In the October 20, 2011 filing, the Company had available to it and used EM&V information current as of May 15, 2011. Thus, at the time of the filing, the statement that the mid-term true-up incorporated the most recent available EM&V results was accurate. Given the point of the revised filing was to correct scrivener's error, the Company did not deem it appropriate to update the filing to include EM&V received between May 15 and December 20, 2011.

5. Please explain whether or not the results of any EM&V were described in the Vintage 3 application? If so:
   a. Please specifically provide where such description is located.
   b. Please explain whether or not the results have been verified by a third party. (Company and ORS)

   RESPONSE:

a. In Exhibit C, the Company provided an update on 2010 program activities along with the projected EM&V schedule for each program. The Company provided specific EM&V results to the ORS and other members of the Collaborative at a meeting of the Collaborative on November 29, 2011.
b. As reviewed in the response to Question 4, the results have been verified by the independent third party evaluation contractor TecMarket Works. This includes EM&V results for Non-Residential Prescriptive Lighting Measures and Smart Saver CFLs as of May 15th, 2011

6. Please describe why the identification of actual KW or kWh savings for Vintage 1 has been delayed? How confident are you that they will be available by the Vintage 4 filing? *(Company and ORS)*

RESPONSE: The delay in the Company's application of EM&V for purposes of truing up Vintage 1 is related to the applicability and the availability of EM&V.

Originally, the Company intended to true-up Vintage 1 in its Vintage 3 filing. While preparing the filing, the Company learned that some confusion existed between the Company and ORS regarding the applicability of the EM&V the Company had received. The Company and ORS now agree on the appropriate application of the EM&V to Vintage 1 and the true-up will occur in the Vintage 4 filing.

Absent the confusion regarding the application of EM&V, the Company still did not have all of the necessary EM&V to perform the Vintage 1 true-up at the time it prepared the Vintage 3 filing. EM&V schedules require flexibility due to numerous uncertainties associated with gathering the information necessary to perform the work. Factors that contributed to the timing of the Company's receipt of the EM&V results included: 1) the timing of regulatory approval in the Carolinas for new programs; 2) the timing of program administration launch schedules; 3) program administration vendor selection issues; 4) shifts in realized customer participation rates over expected rates such that the timing for selecting statistically significant samples also shifted; 5) issues managing billing data and consumption prior to and after installing measures; 6) issues managing measurement data that extends through multiple seasons (summer and winter); 7) identification, through the EM&V process, of data quality control issues which drove the need to clean or re-pull data before analysis could be performed; and, 9) EM&V resource allocation towards measures with the largest impact to the portfolio.

7. Was the mid-term true-up based on EM&V too aggressive of a target to meet? Please explain why or why not. Please explain whether the Company anticipates being able to fulfill all of the objectives of the mid-term true-up in the Vintage 4 filing. *(Company and ORS)*

RESPONSE: When Duke Energy Carolinas entered into the settlement agreement in Docket No. 2007-358-E, a mid-term true-up based on EM&V

seemed reasonable. As indicated in the Company's response to question 6, however, the Company has learned that EM&V schedules require flexibility. The Company's ability to conduct the true-up was based, in part, on when the Company received the EM&V reports for all of its programs from its independent third party evaluator. According to the Company's third party evaluator, it was unable to complete EM&V for all programs in time to support the Vintage 3 filing because not all of the Company's programs had adequate participation from which to take a statistically significant sample for EM&V performance.

The Company believes there was some confusion between the Company and ORS regarding what information would be trued up and when it would be trued up. The confusion has been resolved. The Company now has all the information needed to complete the mid-term true-up and will do so in the Vintage 4 filing.

8. Have you identified the root causes for the lack of success for the Residential Energy Assessments Program, the Energy Efficiency Education Program and the Low Income Energy Efficiency & Weatherization Program? If so, please provide an explanation. Please explain whether any common causes exist. *(Company and ORS).*

RESPONSE: There is no single root cause for the lack of success of the Residential Energy Assessment Program, the Energy Efficiency Education Program and the Low Income Energy Efficiency & Weatherization Program. Below are brief summaries of what the Company has experienced with respect to each of the programs.

While the participation in the Residential Energy Assessment Program has fallen short of the Company's projections, the Company would not classify the program as unsuccessful. The Residential Energy Assessment Program consists of three types of assessments: an Online Energy Assessment, a Personalized Energy Report, and a Home Energy House Call. Two of the three components of this program, Home Energy House Call and Online Energy Assessment have performed well to date while the Personalized Energy Report has struggled to reach the level of participation that was originally projected. Duke Energy Carolinas believes the lack of participation is primarily related to the success of the Residential Smart$aver Compact Fluorescent Lighting ("CFL") Program. It appears that once customers reach the maximum number of CFLs for which they are eligible through Residential Smart$aver, the incentive of providing CFLs for customers who participated in the Personalized Energy Report diminishes. As a consequence, the Personalized Energy Report did not deliver the participation impacts originally forecasted. The Company believes the impacts were simply shifted to the Residential Smart$aver CFL program.

The Energy Efficiency Education Program has not performed as well as anticipated primarily because the program delivery method has not been effective. Effective implementation required engagement and adoption on multiple fronts, including parents, administrators, students, and teachers. Given different directives and priorities from school administrators, curriculum flexibility among teachers regarding which optional programs to adopt, and various degrees of program awareness and participation from parents in completing the home energy surveys with their children, program adoption has been a challenge. After two years of less than anticipated performance, Duke Energy Carolinas has switched program vendors and is currently incorporating a more dynamic live school performance delivery channel that has been well received to date.

The Low Income Energy Efficiency & Weatherization Assistance Program fell short of the performance expectations that were included in the Company's Save-a-Watt filing for two reasons. The primary driver for the less than anticipated performance has been the Company's efforts to cooperate with the State Energy Office of South Carolina's disbursement of American Recovery Reinvestment Act ("ARRA") funds for weatherization. Since the inception of Save-a-Watt, Duke Energy Carolinas has not offered the weatherization or refrigerator replacement components of this program, so as not to have its funds compete with the ARRA funds. After the ARRA funds have been fully disbursed, Duke Energy Carolinas plans to offer the refrigerator replacement and weatherization assistance component of the program. The second reason for under performance is the Company's inability to achieve significant participation in the compact fluorescent light ("CFL") low income agency component of the program. After two years of experience, we have found that during the recession, agencies we were relying on to distribute the CFLs were not inclined to dedicate time and resources to programs they did not consider a high priority. Although the Company did not have success delivering CFLs to low income customers via this channel, the Company effectively met low income customer demand for bulbs through the web distribution channel of its Residential Smart$aver CFL Program. Given this reality, in 2011, the Company stopped offering the CFL low income agency component.

9. In Paragraph 20 of your application, you state that the Low Income Energy Efficiency & Weatherization Assistance Program was not offered to customers. On page 3 of its report, ORS states that program has not been successful. Please explain. *(Company and ORS)*

RESPONSE: Duke Energy Carolinas believes the difference in wording between the Company's application and the ORS Report is related to the fact that the Low Income Energy Efficiency and Weatherization Assistance Program consists of two distinct components. There is a refrigerator replacement and weatherization component, as well as a low income compact fluorescent lighting (CFL) component. As discussed in the answer to Commission Question 8, to date, due to the availability of ARRA funds for weatherization programs, Duke Energy Carolinas has not offered customers the refrigerator replacement and weatherization components. Also as discussed in the answer to Question 8, in 2009 and 2010, the Company did in fact offer customers the low income CFL component of the Program. The Company discontinued offering customers bulbs through this channel beginning in 2011 because the Company found it was meeting the need for CFLs through the SmartSaver program.

10. Please describe whether the approved save-a-watt programs, considered collectively, are producing the anticipated savings within anticipated costs. *(Company and ORS)*

RESPONSE: The Company believes that collectively its portfolio of energy efficiency and demand response programs that were approved under Save-a-Watt have performed very well over the first two years. The costs incurred for the Company's portfolio of programs during the first two vintage years (2010 & 2011) have exceeded the Company's original projections by approximately 20%. During that same period of time, the MWH impacts or energy savings associated with these program costs are over double the amount that was originally projected. This essentially means that the Company has been able to improve the overall cost effectiveness of its energy efficiency and demand response programs versus the original projection.

11. What are the Company's plans for the save-a-watt program after the final true-up in year 6? *(Company and ORS)*

RESPONSE: Duke Energy Carolinas believes that offering its customers cost effective energy efficiency products and services will continue to be an important means by which to engage customers regarding their energy consumption, enabling them to manage their usage and control their bills. Beyond the need to continue to offer customers demand response and energy efficiency programs, the Company has not made any definitive plans regarding the appropriate regulatory approval and cost recovery mechanism by which to deal with the on-going offering of these programs beyond the term of the Save-a-Watt Pilot. Duke Energy Carolinas recognizes the issues that have arisen due to the complexity associated with the Save-a-Watt Pilot, and will consider this in the approach it takes with any future regulatory mechanisms associated with its energy efficiency and demand response programs.

Sincerely,

Timika Shafeek-Horton

Timika Shafeek-Horton

Copy: Shannon Bowyer Hudson (via email)
Frank R. Ellerbee, III (via email)
Bonnie D. Shealy (via email)
J. Blanding Holman, IV (via email)
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Summary Report

Annual Summary of M&V Activities for Duke Energy's Energy Efficiency Programs in South Carolina

Prepared for
Duke Energy
139 East Fourth Street
Cincinnati, OH 45201

March 7, 2012

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About This Summary Report

This report presents the results of all M&V activities that were completed between March 15, 2011 and March 7, 2012, and a summary of evaluation activities that are in progress for Duke Energy's energy efficiency programs in South Carolina.

For evaluations that have been completed, a summary of findings is presented. For evaluations that are currently in progress, a summary of the status of the evaluation along with the expected delivery of the draft report is provided. Planned evaluations are presented with the tasks and timeline for the evaluation.

Completed Evaluations

This section presents the key findings and recommendations for all evaluations completed between March 15, 2011 and March 7, 2012.

2010 Personalized Energy Report Program Impact Evaluation (Exhibit A)

The evaluation report was finalized on November 15, 2011, and is filed as "**Exhibit A – Carolinas - PER and OHEC - Final Impact Evaluation Report - Nov 15 2011**".

Key Findings and Recommendations

This section presents the key findings and recommendations identified through this evaluation. Table 1 presents the estimated overall impacts of both the Personalized Energy Report (PER) and the online version (OHEC).

Table 1: Estimated Overall Impacts from Billing Analysis

	Gross Savings	Net Savings
Per Participant Annual Savings		
kW	0.041	0.035
kWh	378	321
Therms	0.152	0.129

The kWh impacts in this table are from the statistical analysis of participants' monthly electricity billing data. Since the billing data cannot provide estimates of either demand (kW) or gas (therms) savings as well as the net to gross ratio, these impact estimates were based upon the engineering analysis impacts, adjusted by the ratio of the overall kWh savings between the billing analysis and the engineering analysis (0.85%). The engineering analysis also provides insight into impacts by measures (the billing analysis only produces an overall number). Therefore, while the overall result is driven by the billing analysis, an engineering analysis is required as well, so both approaches will be discussed in the report.

Significant Impact Evaluation Findings

- Both the written and online aspects of the program result in statistically significant savings.
- The online survey results in significantly higher savings than the paper version, confirming that online survey takers have higher installation rates than participants who filled out the paper survey.
- The billing data results for the both the paper and online components are larger than the engineering estimate, which may be due to differences between the survey sample and the population on recommended measure uptake. However, for PER®, the confidence interval about the estimate from the billing analysis contains the engineering estimate, so the observed difference between them is not statistically significant.
- CFLs make up 94% of total program savings.

- On average, the 13-watt CFL replaced a 59-watt load; the 20-watt CFL replaced a 73-watt load.

Free Ridership and Spillover

Free ridership was calculated for CFLs distributed to customers who filled out a Personalized Energy Report® survey. The level of free ridership was determined by using the responses to two questions in the survey (found in Appendix B: Participant Survey Instrument). Respondents were asked if they had any CFLs installed in their home prior to completing the Personalized Energy Report® survey, and, if so, how many. The amount of pre-installed CFLs determined the level of free ridership applied to energy savings according to Table 2 below.

Table 2. Free Ridership Factors for Energy Efficiency Kit CFLs

Did you have any CFLs installed before you completed your PER® survey?	If yes, how many?	% Free Ridership
No	n/a	0%
Yes	1 to 3	0%
	4 to 6	25%
	7 to 9	50%
	10 to 12	75%
	More than 12	100%

The percentages of survey respondents in each range of free ridership for pre-installed CFLs are presented in Figure 1 below. These percentages multiplied by the free ridership levels are then presented in Table 3 to arrive at the unadjusted free ridership for CFLs in the Personalized Energy Report® programs. These numbers amount to an unadjusted free ridership of 17.0% in North Carolina and 13.4% percent in South Carolina. There are total of 113 responses in North Carolina and 52 responses in South Carolina for these questions, therefore the weighted average of these percentages gives an unadjusted system freeridership of 15.9% for the Carolinas.

Level of Discounting for Biases

The self-selection bias discount factor for all measures for PER is 29.9%. This is also the full discount for all recommendations. The false response bias discount factor, applied only to CFLs, is 17%. The total discount to CFLs, including freeridership, is then 50.7%. The combined program-wide freeridership and bias adjustment for the engineering estimates is 44.5%. The billing analysis is free of these biases and uses only the 15.9% freeridership adjustment applied only to CFLs. The program-wide adjustment for the billing analysis is 15%. Detailed tables can be seen in Appendix F: DSMore Table.

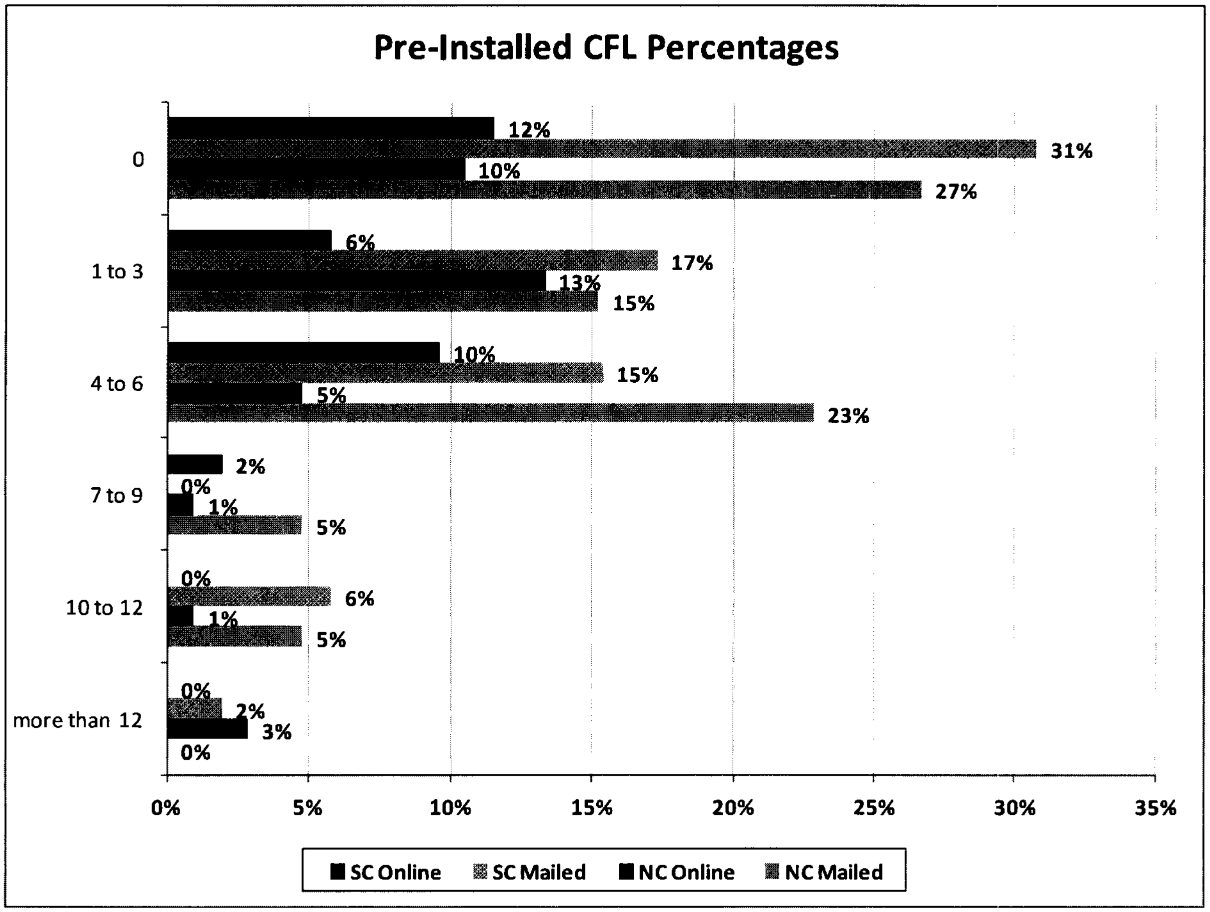

Figure 1. Percentage of Respondents by number of CFLs pre-installed

Table 3. Free Ridership in North and South Carolina

State	Type	Pre-installed CFL range	Percentage in range	Free ridership Level	Free ridership
NC	Mailed	0 to 3	41.9%	0	0%
		4 to 6	22.9%	25	5.7%
		7 to 9	4.8%	50	2.4%
		10 to 12	4.8%	75	3.6%
		More than 12	0%	100	0%
	Online	0 to 3	23.8%	0	0%
		4 to 6	4.8%	25	1.2%
		7 to 9	1.0%	50	0.5%
		10 to 12	1.0%	75	0.7%
		More than 12	2.9%	100	2.9%
Sum of NC Free Ridership					**17.0%**
SC	Mailed	0 to 3	48.1%	0	0%
		4 to 6	15.4%	25	3.8%
		7 to 9	0%	50	0%
		10 to 12	5.8%	75	4.3%
		More than 12	1.9%	100	1.9%
	Online	0 to 3	17.3%	0	0%
		4 to 6	9.6%	25	2.4%

		7 to 9	1.9%	50	1.0%
		10 to 12	0%	75	0%
		More than 12	0%	100	0%
Sum of SC Free Ridership					**13.4%**

Impact Estimates for Personalized Energy Report® Recommendations

The participants of the Personalized Energy Report® Program each received a customized report with specific recommendations for improvements to their home that would increase their home's energy efficiency. In this report, we present the recommendations as they were reported to us by the random sample of 157 participants contacted during the telephone survey. We first asked them what, if any, improvements they had made to their home. We then ask if this was a recommendation that was in the Personalized Energy Report® (PER®). If they said yes (it was in the Personalized Energy Report®), we ask how influential the recommendation in the report was to their decision to install the item on a scale of 1 to 10.

Savings were calculated using engineering algorithms that can be found in Appendix C: Impact Algorithms. Self-selection bias and false response bias are then factored in to calculate the final estimated net impact for engineering estimates only.

Recommendations

- As part of ongoing research related to program marketing effectiveness, Duke Energy has been exploring whether some programs are gateways that potentiate other offers. Research on follow on offer uptake for PER® indicates that customers that first participate in PER® are approximately twice as likely to respond to an offer to participate in Power Manager® as compared to those that did not first participate in PER®. The reverse correlation does appear strong. This suggests that customers participating in PER® should be offered additional opportunities to participate. Perhaps especially in simple offers like Power Manager®. Duke Energy's research on this type of offer progression focuses on the 2009 period, as eventually the universe of participants that *first* received PER® and *then* a Power Manager® offer is reduced, as the total number of Power Manager® offers mailed increases over time. It may be that the ability to migrate customers through programming experiences, e.g. PER® to Power Manager® could drive additional value for Duke Energy, by keeping customers engaged and continuing to offer relevant programming. It may be that engagement programming like PER® drives additional dividends beyond the measurement year. Here for example follow on Demand Response program offer uptake was described. In light of the need to find new ways to get more participation to meet ramping goals, Duke Energy should consider exploring whether this gateway effect exists for other programming types.

2010 Personalized Energy Report Process Evaluation (Exhibit B)

The evaluation report was finalized on July 14, 2011, and is filed as " **Exhibit B - Carolinas - PER and OHEC - Final Process Evaluation Report - July 14 2011**".

Significant Process Evaluation Findings

- The overall participant satisfaction with the program is high at 9.4 on a one-to-ten scale.

- The kit mean satisfaction rating is the lowest of all the satisfaction ratings in the program at 8.4. Respondents stating problems with the kit all referenced the quality of the CFLs. Several respondents said the kit CFLs were too dim, too easily broken, or took too long to warm up.

- The free six pack of CFLs is the most referenced (38% and 40%) primary motivator for participation in the program in North and South Carolina while the desire to save energy was the second-most often referenced primary motivating factor at 35% in North Carolina and 21% in South Carolina.

- Sixty-six participants in North Carolina (63%) and thirty participants in South Carolina (58%) indicated they had at least one pre-installed CFL in their home prior to taking part in the Personalized Energy Report® program. In addition, 15% of respondents in North Carolina and 10% of respondents in South Carolina indicated that they had more than six CFLs installed prior to taking part in the program.

- As part of ongoing research related to program marketing effectiveness, Duke Energy has been exploring whether some programs are gateways that potentiate other offers. Research on follow on offer uptake for PER® indicates that customers that first participate in PER® are approximately twice as likely to respond to an offer to participate in Power Manager® as compared to those that did not first participate in PER®. The reverse correlation does appear strong. This suggests that customers participating in PER® should be offered additional opportunities to participate, especially in simple offers like Power Manager®. Duke Energy's research on this type of offer progression focuses on the 2009 period. Eventually the universe of participants that *first* received PER® and *then* a Power Manager® offer will decline, as the total number of Power Manager® offers mailed increases over time. It may be that the ability to migrate customers through programming experiences, e.g. PER® to Power Manager®, could drive additional value for Duke Energy, by keeping customers engaged and continuing to offer relevant programming.

Recommendations

- Consider increasing the Personalized Energy Report's® ability to provide reports that are more customized to Duke Energy's customers. While the current energy efficiency tips in the Personalized Energy Report® are accurate, they border on being generic and are not focused on the specific needs of the customer receiving them. Tips that are directly tied to customer responses and tuned to local climates and trends are likely to be better heeded.
- Streamline program delivery by consolidating operations within the same vendor whenever possible. This allows easier management for Duke Energy and greater accountability from the vendor for program operations.
- Review areas of overlap between Duke Energy's residential energy report programs: PER®/OHEC (Online Home Energy Calculator) vs. HEHC (Home Energy House Call) vs. HECR (Home Energy Comparison Report). The current number of slightly different residential energy report offerings risk confusing customers who may participate in one residential program and then not know whether they could or should participate in another. Duke Energy needs to make clear if there are different benefits of each program to the customer. It is also critical for Duke Energy to provide consistent messaging and energy tips, in order for Duke Energy to retain its role as the trusted source for energy efficiency information.
- Verify CFL installations and track cross-program participation. Consider increasing the variety of specialty CFLs included in the program offer and tracking the ratio of CFLs to lighting fixtures in residential homes. The two types of CFLs being offered through Duke Energy residential programs are the 13w and 20w medium screw base lamps. These CFLs typically only fit into a few fixtures within a residence, leaving many fixtures that use inefficient bulbs. If more specialty CFLs are offered, the proportion of CFLs to lighting fixtures will increase. This can help maintain high installation rates, and decrease the risk that CFLs will be stockpiled or stored by customers.

2010 Home Energy House Call Process and Impact (Exhibit C)

This evaluation report was finalized on June 13, 2011. The full report is filed as "**Exhibit C - Carolinas - HEHC - Final Process and Impact Evaluation Report - June 13 2011**".

Summary of Findings

Energy Savings

A billing analysis was conducted to estimate the energy savings from the program. The billing analysis relies upon a statistical analysis of actual customer-billed electricity consumption before and after participation in the Home Energy House Call (HEHC) program to estimate the impact for kit and recommended measures from the audit. The billing analysis used consumption data from HEHC participants in North Carolina (5,321 customers) and South Carolina (1,859 customers)[1] that participated between November of 2008 and July of 2010. A panel model specification was used that analyzed the monthly billed energy use across time and participants. The model included terms to control for the effect of weather on usage, as well as a complete set of monthly indicator variables to capture the effects of non-measureable factors that vary over time (such as economic conditions and season loads). The estimated impacts are included in Appendix C: Estimated Model, and a summary of the results are shown below:

	Total
Savings (kWh/yr)	901
T-value	10.39
R-Square	61%
Sample Size (overall model)	293,338 observations (14,001 homes)

The kW and therm savings in Table 4 below were estimated based on the responses to the customer survey regarding what they installed, scaled by the overall population estimate of kWh presented above. Estimates for the free-ridership and spillover were also based on the customer survey, and are discussed in detail later in the report.

[1] Ohio HEHC participant consumption data points (n=6821) were also included in the billing analysis.

Table 4. Summary Table: HEHC Gross Savings and Net Adjustments

Metric	Result
Number of Program Participants	7,180 from Nov. 2008 to July 2010
Gross kW per participant	.105
Gross kWh per participant	901
Gross therms per participant	18.4
Free-ridership rate	• CFLs: 48.3% • Showerheads: 0.6% • Faucet Aerators: 0.6% • Weather-stripping: 12.8% • Outlet Gaskets: 0.8%
Spillover rate	• CFLs: 6.8% • Showerheads: 1.2% • Faucet Aerators: 0.0% • Weather-stripping: 4.6% • Outlet Gaskets: 9.7%
On-site inspection adjustment	• CFLs: 20.7% • Showerheads: 3.0% • Faucet Aerators: 1.0% • Weather-stripping: 7.0% • Outlet Gaskets: 4.0%
Net Adjustments to be applied to Gross values	• CFLs: 43.8% • Showerheads: 97.6% • Faucet Aerators: 98.4% • Weather-stripping: 84.8% • Outlet Gaskets: 104.5%
Total Weighted Adjustments	• kW: 70.8% • kWh: 62.6% • therms: 100.7%
Net kW per participant	.074
Net kWh per participant	564
Net therms per participant	18.5
Measure Life	• CFLs: 5 years • Showerheads: 10 years • Faucet Aerators: 10 years • Weather-stripping: 5 years • Outlet Gaskets: 20 years • Overall Measure Life: 7 years****
Cost-effectiveness for DSMore	

*kW, kWh, and therm savings per participant include both kit items and audit recommendations
**Free-ridership and spillover rates are derived from analysis of participant survey data
***On-site inspection eliminates the need for false response and self-selection bias adjustments
****Overall measure life is a weighted average derived from the effective useful life of the individual kit items. The weights were assigned based on each item's contribution to gross kWh savings.

Customer Satisfaction

Based on 103 surveys done of a random sample of 2,418 participants in North and South Carolina that participated between June of 2009 and January of 2010, the customers' satisfaction with the program is very high with an overall satisfaction score of 9.2 on a 10-point scale. This is a very high level of satisfaction for an energy efficiency program and reflects well on the program and the program's sponsor. They were satisfied with the audit (9.0 out of 10) and with the energy efficiency starter kit (9.3 out of 10).

Motivating Factors

The primary factor was a desire to reduce energy costs with 79 participants (76.7%) indicating it as a factor and 54 (52.4%) indicating it was the most important factor motivating them to participate in the program. Receiving an energy audit was the second-most cited motivating factor.

What Customers Like Most and Least

Customers were most pleased with the free audit and energy-saving kits. The most common area noted for improvement was the need for a follow-up audit and more intensive energy-saving options for participants who had already met all recommendations in the Home Energy House Call audit. These results indicate that customers want to go beyond the typical approaches to energy savings and are looking for other options.

Recommendations

- While customer satisfaction for the audit and kit items is high, many customers expressed a desire for more far-reaching energy-saving options than those presented in the audit. A subset of customers (near 10%) wants to further reduce their energy use and is looking for help to identify any and all approaches for accomplishing their objectives. This indicates that there may be a number of customers who want to go to the next level of energy efficiency and move into the more costly and deeper savings options. One-quarter of the survey participants had already been considering an energy audit before joining the program, and following the audit, 10% requested more information in the form of follow-up services to help identify additional energy saving opportunities. This suggests the Home Energy House Call program has potential for engaging customers who are interested in saving activities that are beyond the low to no-cost savings of the audit report. Duke Energy has an opportunity to capture additional savings from these participants through expanded and coordinated services. In considering these services, Duke Energy should not be limited to only those services that pass a traditional cost effectiveness test, but rather develop services so that the incentives are structured for the individual to make the net savings achieved cost effective. For these additional measures and support needs, the incentives may not need to be as high as 50% of the incremental cost as some of Duke Energy's other programs. For example, if customers need new windows, the incentive can be structured so that the savings are cost effective for that measure.

- Information gathered during the Home Energy House Call audit can be used to identify prospective participants who may benefit from Duke Energy's other energy efficiency programs. This would allow Duke Energy to target promotions and outreach to those who may be more likely to participate in other programs. If the auditors are not currently doing so, the auditors could also present information about other relevant programs during the audit and explain how these could help customers accomplish their energy savings objectives. The home audit is an expensive and unique channel for communicating directly with a homeowner who has already identified themselves as being interested in energy efficiency. Auditors do urge customers to go online to find out about other Duke Energy programs. However, asking customers to go on the Duke Energy website to search for information themselves may incur an information cost. Duke Energy should take advantage of this opportunity to remove that cost and make it easier for the customer to plan future energy efficiency steps. Program auditors need to be representatives of not just the audit, but all approaches by which savings can be achieved.

- Duke Energy should proactively help customers identify higher-cost measures that would have more impact. Past evaluations of the HEHC that was implemented by Duke Energy in Ohio found that customers that have participated in the HEHC do adopt more expensive recommendations such as insulation upgrades. Better promotion of higher-impact measures would allow Duke Energy to contribute to the customer's understanding of energy efficient actions they could take now and later, particularly since customers are not eligible for another Home Energy House Call audit for three years.

- RECOMMENDATION: With the permission of the customer, auditors should remove the old incandescent light bulbs from the customer's home and dispose of them. This would decrease any chance that customers might remove the CFLs and put back the old incandescent light bulbs.

- RECOMMENDATION: Share participant data from other programs that offer free CFLs so that the HEHC participants are not automatically eligible for the additional 12 CFLs if they had previously received a set from another program. This will allow Duke Energy to achieve higher installation rates across their portfolio of programs and achieve greater cost effectiveness from CFL measures.

- RECOMMENDATION: If the regulatory agency allows gas savings to be claimed by the gas utilities, Duke Energy should explore the idea of collaborating with the gas companies to share costs and capture gas savings.

- RECOMMENDATION: Duke Energy should consider tracking customer participation across programs. This would allow Duke Energy to determine whether HEHC might have influenced participants to subsequently participate in other rebate programs. If the referral mechanism is not producing sufficient participation in other Duke Energy energy efficiency programs, consider approaches to increase the effectiveness of the referral mechanism.

- RECOMMENDATION: Duke Energy or its evaluation contractor should schedule an evaluation survey of a sample of HEHC customers to determine their adoption 1 to 2 yrs after participation to identify longer-term savings. This would allow Duke Energy to obtain better longitudinal information about customer actions that might not be captured by annual program evaluations, and better estimate longer-term energy savings.

- RECOMMENDATION: Duke Energy should explore the idea of marketing the HEHC as a limited-time offer within the areas targeted for upcoming service by the auditors. This may increase the perceived scarcity and thus value of the audit, and also would enable audits to be completed within a geographical region before moving operations to another region, increasing cost effectiveness.

- RECOMMENDATION: Duke Energy should help customers prioritize the audit recommendations. Auditors should spend more time finding out what barriers customers might have to the higher savings items so that they might try to address those barriers in a face-to-face conversation with cost effective offers. The HEHC provides a very rare and expensive opportunity for Duke Energy's agents to communicate directly with their customers. Duke Energy should consider using this opportunity to encourage customers to discuss their specific questions and concerns with the auditors with the specific goal of being able to achieve additional savings. Duke Energy should also consider what other unique opportunities might be available through this channel of communication and see how it might best be leveraged. The HEHC should be considered to be much more than just a "live" version of a survey, but should recommend all ways that the customer can save energy and offer incentives on those measures to speed their implementation. For example, if they see that siding or windows are needed, it would be an opportunity to offer underlayment insulation or more efficient windows. Incentives can be calculated to be cost effective.

2010 K12 Curriculum Process and Impact (Exhibit D)

This evaluation report was finalized on November 17, 2011. The full report is filed as "**Exhibit D - Carolinas - K12 - Final Impact and Process Evaluation Report - Nov 17 2011**".

Summary of Findings and Recommendations

An overview of the key findings and recommendations identified through this evaluation is presented below.

There were 8,385 student family participants in the K12 program from June 2009 to April 2010, 6,006 in North Carolina and 2,379 in South Carolina. Table 5 and Table 6 below present the average number of kits distributed by participating teacher, school, and school district. For this program period, there were 113 school districts with participating schools. In these 113 school districts, 850 schools had a total of 1,857 teachers that participated in the K12 program. The average number of kits distributed per participating teacher was 3.3 in North Carolina and 2.9 in South Carolina.

Of the 8,385 kits distributed, 2,503 kits (29.9%) were sent to Non-Duke Energy customers in the Carolinas.[2] These kits contained fewer items, as described in the above text box. Note that these numbers represent the number of Duke Energy customers that completed the survey and requested kits between April 27, 2009 and June 7, 2010, not actual kit distribution. The number of kits sent would be slightly lower because Duke Energy did not send kits to customers that have received energy efficiency kits through other Duke Energy programs.

Table 5. Distribution of Energy Efficiency Kits in North Carolina

Jurisdiction: NC	Average Number of Kits Requested by Non-Duke Energy Customers	Average Number of Kits Requested by Duke Energy Customers	Total Kits Requested	Range of Number of Kits, Duke Energy and Non-Duke Energy Customers
School District (n=74)	21.9	58.1	6006	0-491
School (n=624)	2.6	7.0		0-145
Teacher (n=1,324)	1.2	3.3		0-35

Table 6. Distribution of Energy Efficiency Kits in South Carolina

Jurisdiction: SC	Average Number of Kits Requested by Non-Duke Energy Customers	Average Number of Kits Requested by Duke Energy Customers	Total Kits Requested	Range of Number of Kits, Duke Energy and Non-Duke Energy Customers
School District (n=39)	21.4	38.1	2379	0-644
School (n-226)	3.8	6.7		0-169

[2] 1,646 out of 6,006 (27.4%) kits went to Non-Duke Energy customers in North Carolina. 857 out of 2,379 (36.0%) kits went to Non-Duke Energy customers in South Carolina.

Teacher	(n=533)	1.6	2.9		0-45

Evaluation Contractor's Recommendations for Duke Energy to Consider

The following program recommendations are provided by TecMarket Works, the independent evaluation contactor. The recommendations are provided to allow Duke Energy to review them with the program manager and the lead administrator so that each recommendation can be accepted, rejected or modified according to the best judgment of the program design professionals.

1. **Develop a coordinated school targeting and entry-contact strategy that takes advantage of all effective market development efforts to reach newly targeted schools.** For most schools targeted by the program, successful entry into the school is based on Scholastic's market presence and history serving schools, and their reputation as a curriculum builder. This is the primary market development theory regarding why delivering the program through organizations like Scholastic is the preferred approach. It builds on existing relationships and service history. That is, the program delivery success hinges on Scholastic's presence and reputation as a high-quality training support organization to the schools targeted by the program. However, teacher interviews suggest that for some schools, Duke Energy's Business Relations Manager (BRM) relationship with the schools can also be a "door opener" and may, in some circumstances, provide a more effective access route to the school administrators who need to approve the program for their schools. In addition, Duke Energy has other relationships that can be used to gain support. For example, the Duke Energy Foundation has contacts with school administrators and teachers and provides supportive funding to many schools. They also take part in school board activities and support educational development in the state via a number of efforts. For some schools, entry into the school can be expedited by leveraging Duke Energy' existing relationship through their BRMs[3] or through Duke Energy's extended community relations. These relationships and organizations can be considered when developing a school district contact strategy. This strategy can employ a phased approach for gaining access to new schools so that the support for the program is present and the administrators are receptive enough that they can push the push the program within their schools.

2. **Select program assessment metrics carefully when evaluating second year program energy savings.** Because the second program year will be implemented with several design changes as well as different fielding approaches compared to the first year, it will be important to understand the relationship between program operations and success (energy savings). Duke Energy and Scholastic should consider developing a set of performance metrics that help track the effects of the program to the operational components that deliver that success. One approach would be to develop several metrics and assess the success of the program across these multiple metrics so that the assessment

[3] BRM: Business Relations Managers, sometimes knows as the customer representatives

focuses on savings achieved but also for delivery effectiveness. Such metrics can include savings per teacher, savings per school, savings per district, installations per teacher, surveys and return cards returned per teacher/school/district, students reached per month, etc. These performance metrics can then be compared with the program's operational procedures to identify changes that increase effectiveness and those that do not.

3. **Train program team members on the methodology that is used to calculate energy savings.** All team members should be made to understand that the energy savings are estimated by extrapolating the data from the measures reported on the BRC to the entire population. The requirement to achieve a at least a 20% rate of BRC returns stems from the need to minimize self-selection bias by drawing a sample from a wide range of households, not just those households that might already be more receptive to energy efficiency. This better understanding may allow program team members to find other ways of increasing the representativeness of the sample without resorting to high BRC return incentives. See next recommendation as an example.

4. **Consider other methods of decreasing response bias by increasing representativeness of the BRC sample.** The survey and BRC returns that the program is experiencing at this time should be considered the minimum level of acceptance for those teachers who have adopted the program for their classrooms. Surveys and BRC returns should be much higher. We see no reason why surveys and BRC return rates should not be provided by 50% of the students and their parents if it were presented as a homework assignment. Methods should be developed for increasing the BRC response rates. For example, playing upon known methodologies for multi-student partnership efforts, such as randomly divided into pairs and every pair could be asked to make a commitment to have at least one student return the BRC from each pair and the other report to the class the measures installed. The random pairing of students would decrease response bias by encouraging responses from students who tend not to respond.

5. **Work with neighboring utilities to share credit of achieving energy savings.** In a time when energy efficiency and carbon reduction is of increasing importance, growing numbers of states have school energy efficiency programs that overlap geographical regions. While it is important to understand an individual program's achievements for the purpose of improving program operations and program design, utilities should be given energy savings credit for contributing to overall energy supplies in their states and their market transformation efforts to achieve an energy supply objective. A case made to the regulatory agencies for sharing credit would be strengthened by coordination between neighboring utilities. However, splitting individual students within a single class to receive different levels of support based on the location of their parents homes can be expected to substantially decrease cost effectiveness by driving up costs per in-territory student and lower savings by not including all students. We recommend working with the Commission to resolve this issue to: a) count all savings regardless of territory, or b) exclude this program from a cost effectiveness requirement and allow recovery of all costs and incentives as a condition of implementation, or 3) determine if the program can be made cost effective through continued improvements such that it can become cost effective by counting only the savings from homes in Duke Energy's territory, or d)

consider terminating the program. We specifically recommend that Duke Energy work with the Commission to allow savings from schools operating in multiple utility territories to be credited to the sponsoring utility so that territorial issues do not impact program energy credits or act to erode the apparent cost effectiveness of the program. Base the argument on the fact that it is the energy supplies of the state that are the focus of the legislation and or regulatory policy behind cost effective energy supplies provided to the energy consuming population of the state. If this is not successful, examine the cost effectiveness of the program based on Duke Energy's territory savings and determine if the program is cost effective, can be made cost effective, can be exempted from contributing to a cost effective portfolio, or if it should be terminated.

6. **Continue to explore new program operations, enrollment, and marketing strategies to increase program cost effectiveness.** Duke Energy is working with Scholastic to test new approaches for improving the design and operations of this program. We compliment Duke Energy and Scholastic for their continued efforts to improve the program and encourage the continuation of this improvement approach. For example, in the Carolinas, Duke Energy is considering a new school strategy that does not require in-person visits. For this strategy, DVD presentations are being considered as a way to market to schools that are geographically hard to reach, making personal visits expensive. In assessing this strategy Duke Energy and Scholastic should continue to explore whether DVD is an effective presentation tool for serving as a replacement for in-person program enrollment visits. If this strategy is effective in the Carolinas, consider using this approach in Ohio as well.

   In addition, there is some concern on the part of Scholastic that mass marketing efforts are not permitted. Scholastic, on the other hand, recommends the use of local mass marketing efforts to develop positive community support for the program prior to contacting administrators and teachers during the enrollment phase. These options should be tested to determine what actions are worth perusing on a program basis. However, these efforts have to be considered within a cost effectiveness framework for the program as a whole within the portfolio. If the program cannot be made cost effective, it makes little sense to spend additional dollars building public support for a program that will not continue as a part of the portfolio. We recommend that both Duke Energy and Scholastic explore these and other options to build a program that is both cost effective and that uses an approach that improves response, participation and energy savings to become more cost effective over time.

7. **Review how many 3rd and 4th Grade classes the targeted schools have so that schools receive the appropriate number of teacher kits.** The number of 3rd and 4th grade classrooms was over-estimated in the 2009-2010 program year, resulting in too many kits being sent to the teachers. This was not reported as an issue in the current evaluation, and the average number of kits per school dropped from 11 in 2009 to 7.6 kits in 2010. This issue has likely been resolved as of this report, though further inquiries should be performed to ensure that the appropriate number of teacher kits are being distributed to the schools.

Teacher-Provided Recommendations for Duke Energy To Consider

In addition to the recommendations provided by the evaluation contractor, several teachers provided recommendations that can be considered by the program design professionals. TecMarket Works presents these recommendations from the interviewed teachers from both the Ohio program and the assessment of the program in the Carolinas so that ideas expressed across both states are considered within each state. However, we do not elevate these recommendations to be included with the recommendations from the evaluation contactor. The evaluation contractor recommendations are those that TecMarket Works suggest be implemented into the program (above). The teacher recommendations are provided without judgment as to their appropriateness for the K12 program. These including the following:

- Increase the level of educational and results-related program promotions (flyers, brochures, school examples, etc.) provided to the teachers and school administrators in time to be effectively used.
- Update the program materials to today's standards by adding a multi-media element such as a DVD video or online class activities.
- Develop and incorporate a day-to-day educational/activities planner to stretch the impact of the activities out over several days
- Add a more flexible incentive for teachers to make the effort worthwhile to the teachers who are responsible for success; the incentive can be cash for the class, class activities, or credits for class supplies or other incentives valued by teachers.
- Redesign the website to make it more user-friendly for students and teachers
- Add more online content for students to access at home that would focus on increasing key behaviors and measure installations.
- Develop a simple game for the students to play with their family that would reinforce the behaviors needed and the installation of measures. Distribute it with the kit.
- Develop a song that students can sing in the class or at home that sends a behavior and use message.
- Develop a downloadable application for smartphones that parents and children could use together to track their savings.
- Include a component in which the students write a report of the use of the kit items and have the program incent the report to make it attractive to students and teachers.

Teacher Comments

The teachers also provided additional comments on the program and its operations. These comments are summarized below.

- "The packet of materials was great. Children love being able to touch and hold things."
- "The lessons were brought down to the right level for my class, and "The Magic School Bus" holds a high level of interest for children."

- "The prepaid envelopes were great. We didn't have those last year and I think it made a real difference."
- "The materials need to be designed specifically for the children who are to be exposed to them. The lines of type in some of the materials are still too small."
- "Bring out the integration between the Magic School Bus story and the curriculum's focus and the program's objectives so that they directly support each other."
- "Add more multimedia elements – online, songs, videos, presentations."
- "Need to more effectively structure the program's focus and materials so that it integrates smoothly with the school curriculum that we must follow as well as state standards."

Student Family Surveys (Business Reply Cards, or BRCs)

One hundred sixty-two (162) families that live in Duke Energy's service territory in the Carolinas returned the BRC. The survey asked the families about what kit items they used and their satisfaction with the items. The most commonly installed items with over 80% installation rates were the kit's 13-watt and 20-watt CFLs and the night light. Respondents also indicated their highest levels of satisfaction with the CFLs, as presented in the table below.

	Percent Installed or Used	Mean Satisfaction Score
13-watt CFL	88.9%	8.8
20-watt CFL	82.7%	8.9
night light	81.5%	8.5
booklet	75.3%	8.5
low flow showerhead	70.4%	8.5
kitchen aerator	61.7%	8.5
bathroom aerator	56.2%	
switch and outlet gaskets	53.1%	8.3
water temp card	49.4%	8.4
water flow meter bag	19.8%	7.6

Impact Findings

Table 3 presents the per customer kWh savings associated with the K12 program. These results are obtained based on the results of the billing data analysis. Since the billing analysis uses actual energy usage to estimate impacts, and is the entire population of Duke Energy participants, it was deemed that this is a more accurate estimate of the program impact than the estimate from in the engineering analysis.

Table 7. Energy savings associated with the K12 program

	kWh	t-value
Per Participant Annual Savings (Gross)	249.2	6.00
Per Participant Annual Savings (Net)	205.2	6.00

The kWh impacts in Table 7 are from the statistical analysis of participants' monthly electricity billing data. Since the billing data cannot provide insight into impacts by measure, these impact estimates were based upon the engineering analysis impacts, adjusted by the ratio of the overall kWh savings between the billing analysis and the engineering analysis (23%). The engineering analysis also provides the net to gross ratio. Therefore, while the overall result is driven by the billing analysis, an engineering analysis is also required. Both approaches are discussed in the report.

2010 Power Manager Process and Impact (Exhibit E)

This evaluation report was finalized on September 2, 2011. The full report is filed as "**Exhibit E - Carolinas - Power Manager - Final Process and Impact Evaluation Report - Sept 2 2011**".

Summary of Findings

Customer Satisfaction

- Satisfaction with the Power Manager program is high with over 70 percent of the survey respondents rating their satisfaction at a 9 or 10 on a 10-point scale for all program aspects: Overall program, program enrollment, and program information.

Motivating Factors

- More than half (61.8%) of the surveyed North Carolina participants were able to recall any benefits promoted by the program. In South Carolina, 53.5% were able to recall at least one benefit promoted by the program. The surveyed participants that did recall program benefits were able to provide 63 benefits that they recalled being promoted by the program. Of the 63 benefits recalled by these participants, 75% of them mentioned money either by recalling the bill credits or financial incentives for participating in the Power Manager program.

- Most participants rate environmental issues as important or very important to them. However, a small number of them (about 7%) are a member of an organization with an environmental mission.

- More than half of the participants in both states do not know when control events occur, or even notice the bill credits on their bill. However, the bill credits are the most commonly cited reason for their participation in the program.

Recommendations

- **Process Recommendation**: Bring on additional staff to help answer phone calls and email during events, and to assist with the administrative needs. Although the interviewees state that Duke Energy's management is aware of the need for more staffing, it is worth emphasizing this need. Demand response programs usually only a have a few opportunities each year in which they are visible to the customer and it is critical to ensure that program operations run efficiently in the eyes of the participant during those times, and that all customer concerns during events are addressed promptly. While the Power Manager® team has succeeded with their existing staffing, interviewees express concern that their ability to respond to customer concerns during events may affect their ability to provide technical oversight of the event once it's initiated.

- **Process Recommendation:** Events may be called for economic or emergency reasons. In the Carolinas, the Duke Energy's System Operations Group determines emergency situations. Duke Energy's RED determines when economic events are called. Economic events are to prevent the market's energy cost fluctuations from negatively affecting customers. In program planning, continue to balance the number of economic events with the possibility of emergency events. Duke Energy also needs to carefully balance customer satisfaction with both emergency and economic events. Where emergency events increase, customer dissatisfaction needs to be mitigated through increased communication, and possible media coverage.

- **Process Recommendation**: Consider leapfrogging the Cannon switch technology in favor of a switch that allows two-way communication, or one that can be integrated with a Smart Grid. Switch upgrades are underway and will be completed in two or more years, but Duke Energy program staff is aware that in that time, the upgraded switches themselves may be outdated as state-of-the-art developments continue to occur with equipment or Smart Grid infrastructure. Duke Energy staff has expressed a need for two-way communications in order to achieve effective program management and savings acquisition.

- **Impact Recommendation**: A potential alternative approach for future impact evaluations is to use the data from the M&V and the operability sample to directly estimate impacts via statistical models. This data can be used to develop a statistical model that estimates the actual load impacts during previous events as well as the providing and estimated of peak weather impacts. In spirit, this approach is similar to the duty cycle approach, but the impact estimates are obtained directly from observed data, rather than simulated from data on non-event days.

2010 Smart $aver CFL Process and Impact (Exhibit F)

This evaluation report was finalized on February 15, 2011 and revised on April 26, 2011. The full report is filed as "**Exhibit F - Carolinas - Smart $aver CFL - Final Process and Impact Evaluation Report - Revised April 26 2011**".

Findings

1. Duke Energy's CFL coupons are very popular with retailers, boosting sales 500 to 1,000 percent over typical sales, in some cases causing stores to move product from non-Duke Energy territories, providing substitutions and extending expiration dates for offers. This is a substantial increase in sales and reflects well on Duke Energy and on their marketing efforts and promotional initiatives. Duke Energy managers report large movements of CFLs in all Duke Energy territory stores carrying the GE brand with retailers reporting sales as fast as they can stock the covered bulbs.

2. Discount coupons are recently experiencing diminishing returns as far as reaching new customers to redeem the price reduction the coupons. Strategies are now being implemented to reach non-coupon users. Additional targeting and motivational appeals at younger and more mobile customers who are less likely to redeem coupons is needed if the use of discount coupons is maintained to increase redemption from this group. However, Duke Energy has moved to a no cost coupon for a free 6 pack of CFLs that has increased sales of CFLs to the point where the market is having trouble stocking bulbs and retailers are asking for advance notice of coupon distribution to enable them to have enough stock in the stores. Duke Energy managers report that redemption rates are running between 20% and 25% compared to about 3% with the price reduction coupons.

3. The strategy of using individual customer-coded coupons allows Duke Energy to focus on accurately tracking customer purchases rather than reconciling participation and sales counts with retailers. The move to customer-specific coupons also allow Duke Energy to move away from a store-focus program to a customer-targeted program, a more efficient method of operation that can expand and contract as needed by including or not including customers in direct mail targeting. The method also allows for strategic geo-expansion of the program by targeting more areas rather than increasing coordination with specific stores. This also allows Duke Energy the flexibility of moving between a discount coupon and a free bulb coupon to match the energy and cost effectiveness goals. This method has also allowed Duke Energy to identify a few (less than 10) customers who have copied the coupon in order to obtain more than the maximum number of free bulbs.

4. Home Depot (for example) did not carry the partnered brand resulting in a large CFL retailer not being allowed to participate in the program. The manufacturers' coupon was successful in acquiring cooperation with other specific retailers, such as an expansion into Wal-Mart. Since the coupon campaign, Duke Energy has also allowed customers to acquire the CFLs over the web if they cannot or are unable to go to one of the retail outlets, increasing exposure and adoption rates. In the web process Duke Energy can validate the potential participant's status as a Duke Energy customer and verify that they are eligible for the CFLs. This allows Duke Energy to mail only the number of bulbs that

the customer is eligible to receive (up to 15 bulbs) by using a real-time database verification to see if they have redeemed a coupon in the past.

5. Retailers report that the coupons significantly affect sales and a discontinuation of the program would result in much fewer CFLs purchased as well as a significantly lower focus on CFL sales by the retailer.

6. Retailers report they need additional lead time to acquire additional stock because of the higher sales volumes that have occurred after Duke Energy's coupons were distributed. This is a problem growing out of the success of the effort. That is, the effort was successful enough that the retailers report needing extra time to obtain inventory from their non-Duke Energy territory stores to support the increased sales. Also, because of the increased demand and the strong customer acceptance, retailers report that coupons should have longer duration periods to allow them to not expire so quickly and allow participants more time to redeem their coupons. GE reported sending out 1.5 million postcards to Duke Energy's customers to let them know that they could still redeem their coupons after the expiration date to compensate for lack of stock. To be fair to Duke Energy, it should be noted that the program had advised retailers to stock more bulbs than they would have normally needed. However, few of the retailers took this action.

7. CFL coupons were far and away the primary driver for participants to purchase CFLs, and more than 40 % of coupon redeemers indicated that they would have purchased zero CFLs if the Duke Energy coupon had not been available.

8. While CFL coupons are driving spillover to more CFL purchases, the coupons are having only a small effect on simultaneous purchases of other energy efficiency technologies such as insulation and weather stripping.

9. Of the CFLs redeemed with coupons, 90% in North Carolina and 84% in South Carolina were reported to be installed and operating in sockets at the time of the survey.

10. Prior use of CFLs had no bearing on CFL program satisfaction ratings of CFL redeemers or self-reported likelihood of redeemers purchasing CFLs in the future, however those redeemers who experienced any bulb failure or removed at least one CFL because of light quality had a lower overall satisfaction rating with CFLs.

11. Prior use did have an effect on forward-looking confidence in CFLs with more new adopters than previous adopters finding they were much more confident in CFLs after participating in the program.

12. CFL forward-looking buying and installation habits are similar for new and previous adopters

Energy Savings Summary

Gross Energy Savings Calculations

Past evaluations have indicated that self-reported hours of use tend to over-estimate estimated savings by over-estimating typical hours of use. As a result, in order to reliably estimate energy impacts, it was necessary to use the results of the logger study that recorded the actual hours of use. This allowed the impact estimate to be based on the measured hours of use, times the difference in wattage between the lamp replaced and the lamp installed, as reported by the participants. From this calculation there is a gross yearly energy savings of 46.9 kWh per lamp in North Carolina and 40.3 kWh per lamp in South Carolina.

Free Riders and Free Drivers

From the survey results, it was determined that 19% of CFL purchases made were due to free riders[4], while 32% of purchases made were due to free drivers[5] for a net-to-gross adjustment factor of 107% excluding additional market effects caused by the program beyond the participant purchases[6].

Total Program Net Energy Savings Calculations

Program impacts are presented in the Impact Evaluation Summary Table below.

Table 8. Impact Evaluation Summary Table

Metric	North Carolina	South Carolina
Total lamps redeemed	1,619,990	490,670
ISR	0.9053	0.9102
Gross kWh per lamp redeemed	42.4265	36.6900
Gross kW per lamp redeemed	0.0445513	0.0378810
Coincidence Factor	0.123	0.123
Gross Coincident kW per lamp redeemed	0.0055	0.0047
Total Gross Program MWh Savings	68,731	18,003
Total Gross Program kW Savings	72,173	18,587
Total Gross Program Coincident kW Savings	8,877	2,286
Free rider adjustment	0.81	0.81
Spillover adjustment	1.32	1.32
Net to gross ratio including spillover	1.07	1.07
Total Net Program MWh Savings (free riders only)	55,672	14,582
Total Net Program kW Savings (free riders only)	58,460	15,056
Total Net Program Coincident kW Savings (free riders only)	7,191	1,852
Net kWh per lamp redeemed (free riders only) (A)	34.37	29.72

4 Free rider: someone who would have taken the same action without the program's influence.
5 Free driver: someone who takes additional actions as a result of the influence of the program.
6 As retailers focus on stocking and displaying more CFL products as a result of the program's marketing push, additional sales are generated by non-participating shoppers. This study excludes the savings acquired by non-participating customers as a result of the way in which the program influenced total CFL sales.

Net kW per lamp redeemed (free riders only)	0.0361	0.0307
Net Coincident kW per lamp redeemed (free riders only)	0.0044	0.0038
Total Net Program MWh Savings (free riders plus spillover)	73,542	19,263
Total Net Program kW Savings (free riders plus spillover)	77,225	19,888
Total Net Program Coincident kW Savings (free riders plus spillover)	9,499	2,446
Net kWh per lamp redeemed (free riders plus spillover) (B)	45.40	39.26
Net kW per lamp redeemed (free riders plus spillover)	0.0477	0.0405
Net Coincident kW per lamp redeemed (free riders plus spillover)	0.0059	0.0050
Measure life	5	5
Lifetime net MWh savings (free riders only)	278,359	72,911
Lifetime net MWh savings (free riders plus spillover)	367,708	96,314

(A): Net kWh per lamp redeemed, for the free riders only, is calculated using the total net program MWh savings (free riders only) divided by the total lamps redeemed.
(B): Net kWh per lamp redeemed, including both free riders and spillover, is calculated using the total net program MWh savings (free riders plus spillover) divided by the total lamps redeemed.

* While the advertised expected life of the installed CFLs is greater (10 years), recent research in California has indicated that CFL bulbs installed in typical rooms have switching behaviors that erode about half the advertized effective useful life. The adjustment approach for reducing the effective useful life to 5 years is presented in Appendix E: Effective Useful Life Adjustment Factor for Installed CFLs.

Recommendations

TecMarket Works and Building Metrics offer the following recommendations for the Smart $aver® CFL Program.

1. Consider conducting light logger studies at different times of the year to observe the daylength effect. Doing the logging studies over the equinox removes the daylength effect from the logger data. However, if Duke Energy would like to study the magnitude of the daylength effect, the evaluation team will need to design an experiment that would require logging at different times of the year. Doing so will involve much larger samples and a longer timeframe than what was needed for this or previous studies, so this should be considered carefully given the budget and timeline expansions needed if Duke Energy would like to explore this effect in future evaluations.

2. Link light logger installations unambiguously to self-reported hours of use data.

3. Continue use of targeted marketing efforts to identify customers most likely to purchase CFLs during the specific promotion or campaign. 2008 targeted messaging analysis shows that targeting messages to customers based on likelihood of adoption is successful in providing lift to populations that were not as likely to purchase CFLs. (Note: during the drafting of this report Duke Energy has continued testing motivational message content and redemption rates and reports that they have narrowed the messaging to energy and environmental appeals that experience the higher adoption and redemption

rates and have moved to the use of free product coupons that together are substantially increasing redemption rates for CFLs.)

4. Savings for typical CFL bulbs may decrease over the long term as more customers adopt CFLs and continue to install bulbs in lower use sockets and fixtures. Recognizing the need to cost-effectively distribute CFLs, Duke Energy designed a tracking system to mitigate over-distribution of traditional CFLs. Consider transitioning the CFL program to incorporate other types of CFL offers, such as specialty bulbs (candelabras, torchieres, outdoor, etc.), LEDs, and other emerging technologies as they become cost effective. (Evaluation Review Follow-Up Note: Duke Energy reports that they are currently examining the inclusion of specialty bulbs to understand their potential with both past CFL redeemers and previous purchasers of CFLs as well as approaches for reaching new customers with specialty bulb appeals and offers. In addition, TecMarket Works is currently assessing the market for CFLs and will address the potential for specialty bulbs in the CFL potentials report to be delivered in April 2011. Duke Energy also reports that CFL adoption has increased due to offering web and phone-based ordering platforms where CFLs can be shipped directly to the customer's home as soon as they are ordered. Duke Energy customers can check eligibility and request CFLs by accessing a unique URL or OLS (Online Services) or by calling a toll-free number.

5. Consider incorporating a market effects study to identify ways to transition the program moving forward as traditional incandescents are phased out in the coming years, as shown in Table 9 below.

Table 9. EISA Schedule for General Service Incandescent[7]

Current Wattage	Rated Lumen Ranges	Maximum Rated Wattage	Minimum Rated Lifetime	Effective Date (Manufactured on or after)
100	1490-2600	72	1,000 hours	1/1/2012
75	1050-1489	53	1,000 hours	1/1/2013
60	750-1049	43	1,000 hours	1/1/2014
40	310-749	29	1,000 hours	1/1/2014

6. Consider coupling CFL efforts with other energy saving measures and/or programs. Customers did not buy many other energy efficiency items in addition to the CFLs when making their CFL purchases. Program managers could leverage both redeemer and non redeemers' awareness of ENERGY STAR to incorporate other energy saving items and/or encourage customers take other energy saving actions at the same time they are purchasing CFLs. Coupon redeemers purchased other energy saving measures (caulking, weather stripping, low-flow showerhead) in small quantities and might be interested in other simple energy saving measures if they were co-marketed with a CFL offer. Both redeemers and non redeemers may be interested in such measures as ENERGY STAR appliances, or other Duke Energy programs offering energy efficient measures such as

[7] Source:
http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/lighting_legislation_fact_sheet_03_13_08.pdf

HVAC or home audits. (Evaluation Review Follow-Up Note: Duke Energy reports that they have already started coordinating program services to include multi-product appeals and exposure in their small business programs, the Home Energy House Call program, neighborhood canvassing, and are considering other programs that can act as aggregation efforts to expose customers to multiple measures.)

7. Non coupon redeemers are generally not influenced by receiving Duke Energy coupons to purchase CFLs elsewhere, however, the price of CFLs is a factor for these customers. Consider additional marketing strategies for these customers that incorporate the Duke Energy reduced price of CFLs, recommendations of friends and family, and other types of advertising appeals. These customers were more influenced by in-store advertising than the coupon redeemers, so other types of offers for CFL savings, such as point of purchase offers, may appeal to these customers. (Evaluation Review Follow-Up Note: Duke Energy reports that they have started these efforts with property management programs, business reply cards and web campaigns.)

2009 Low Income Process (Exhibit G)

This evaluation report was finalized on September 22, 2010, but inadvertently omitted from the Annual Summary of M&V Activities dated March 15, 2011. The full report is filed as "**Exhibit G - Carolinas - Low Income CFLs - Final Process Evaluation Report - September 20 2010**".

Summary of Findings

This Executive Summary provides an overview of the key findings identified through this evaluation.

Significant Process Evaluation Findings

- Duke Energy is not meeting its participation goals for the Low Income CFL Program. Duke Energy would like to increase participation and the subsequent Save-A-Watt (SAW) impacts through the Low Income CFL Program or other Low Income Programs. However, operational pressures, limited staff, low operating budgets, increased service demand from low income service agencies, and ARRA fund compliance will continue to limit participation achieved through the agencies.

- Agencies serving low income clients in North and South Carolina have varying levels of capacity available. Some agencies do not have the time and/or staff resources to take the time to go through the Portal's survey with their clients, and could not identify a way for Duke Energy to help them with this problem outside of Duke Energy staff being present in the waiting rooms to offer the survey. Other agencies could likely increase the number of Energy Efficiency Surveys completed if they were provided with printed client motivation materials, such as posters to put up in the agency and printed surveys that can be mailed in by the client.

- While several agencies do not have the time to use the Portal, all of the visited agencies were very satisfied with availability and operations of the Portal, and the web-based method for submitting the Energy Efficiency Survey results. None of the visiting agencies had serious issues with the Portal.

- Many of the agency staff providing the low income services are not seeing or not reading the Duke Energy e-mail "encouragement" marketing efforts aimed at promoting the use of the Portal and the distribution of the CFLs via the survey approach.

Recommendations

The following recommendations are based on interviews with staff in low income agency offices and with the program manager at Duke Energy.

- **Issue 1:** Duke Energy is currently offering only one of the three planned low income programs in North and South Carolina, the CFL Program. The Weatherization and Refrigerator Replacement Programs have not been launched.

Duke Energy has not launched these two low income programs because there are large pools of unspent federal funds for weatherization services currently available from the American Recovery and Reinvestment Act. Service agencies are under pressure to spend these funds over the next two years and spending goals are behind federal objectives for rapid deployment of federal weatherization services. Duke Energy does not want to compete against the federal government for limited implementation services or complicate the operations of the low income and/or weatherization agencies with dual funding streams, dual approved measure lists, dual reporting requirements and different weatherization program goals.

Recommendation 1: Instead of delaying the launch of these programs indefinitely, Duke Energy should contact the low income agencies and investigate ways that Duke Energy can provide their low income customers with measures and services to reduce their energy consumption without causing the low income agencies unnecessary operational difficulties. For example, Duke Energy can fund measures that are cost effective, while federal funds can be spent on longer lasting, less cost effective measures. However, finding weatherization service providers who are receptive to this dual funding, dual measure assessment approach may be difficult until the agencies can catch up with their federal spending objectives and energy goals. As ARRA funds available to the service providers near exhaustion, Duke Energy will find that these agencies will need to find additional funding streams or terminate hired staff. Over the next 12-16 months Duke Energy will find local service agencies becoming more interested in providing services funded by Duke Energy. However, at this time agencies are focused on spending the ARRA dollars and finding enough staff and clients to meet their spending goals. Agencies not affiliated with ARRA (weatherization, state energy programs, and block grant initiatives) and the traditional federal weatherization initiatives remain prime targets for negotiating service agreements for their clients to the extent that these clients are not serviced by other weatherization providers.

- **Issue 2**: The $1 to cover the increased costs and time needed to complete the survey is, in most cases, not enough to cover costs.

  Recommendation 2: An increase in submitted surveys would require either higher payments to be made by Duke Energy or an alternative incentive structure, combined with marketing material support for the agencies. In addition, many agencies that do provide the surveys are not aware of ever receiving a Duke Energy incentive check for their efforts since the checks are sent to a different office in their organization. Thus, the people conducting the surveys with their clients are often not aware that their agency benefits from that effort. To most agencies, the only known incentive offered for participation in the Low Income CFL program is the free 12-pack of CFLs mailed to the low income client. Duke Energy should examine the incentive and marketing support operations to determine if there is enough cost-effectiveness in the initiative to provide marketing support and agency compensation to cover costs and help reach survey completion objectives.

- **Issue 3**: Not all of the low income service agencies are interested in offering the survey.

  Recommendation 3: Each of the offices that have access to the Portal should be asked if they would like to offer the surveys to their clients in exchange for an incentive from Duke Energy. Market the financial support to customers and agencies by sending a Duke Energy speaker to events geared to low income service providers that includes talking point slides to managers at agency offices so that support comes from both top down and bottom up.

  If the low income agency is interested in participating and providing the surveys to its clients:

  - Encourage participating offices to make the Energy Efficiency Survey a part of their client intake process.
  - Posters marketing the survey and free CFLs (and their energy and bill savings benefits) for their waiting areas should be considered by Duke Energy.
  - Paper copies of the surveys should be provided by Duke Energy for the case workers and for the clients to take home in case they do not have or do not know their account number. Postage paid envelopes were suggested, but other offices have said that they are not necessary as most clients are willing to pay for postage to get the free CFLs, or will bring the survey back to the office during their next visit.
  - Encourage the low income agency offices to distribute paper copies of the survey throughout all offices that serve low income clients.

  If the office is not interested in providing the Energy Efficiency Survey to their clients, there is no need to send paper copies of the survey or promotional materials. If an office does not want to offer the Energy Efficiency Survey, it is likely because they do not have the time and staff resources to administer the survey or they have a low percentage of clients that live within Duke Energy's service territory. Therefore, survey and promotional materials will likely be discarded and may negatively affect the relationship between that office and Duke Energy.

- **Issue 4**: Agency staff are not always reading the emails from Duke Energy, so they may not be aware of program changes, issues, etc.

  Recommendation 4: Continue other approaches in addition to e-mail marketing to the service providers. Continue direct marketing of the program to service agencies via personal visits and "sales calls" and move away from relying on the use of e-mail promotional efforts as the primary "encouragement" approach or specifically target those efforts at the staff that provide the interaction-based service with the client. Consider hard-copy mailings or "encouragement" pieces, direct telephone calls with provider agency staff, personal visits with provider agencies, and alternative incentive mechanisms that cover the cost of providing the service. Consider the use of spiffs or bonus rewards to staff who submit a targeted number of surveys.

- **Issue 5**: The Energy Efficiency Survey is collecting demographic and home profile data that should be incorporated into analyses, such as insights into Low Income customers, cross selling, target market modeling, and marketing message testing being performed by Duke Energy. However, this data is not being analyzed at this time.

  Recommendation 5: The data collected through the Energy Efficiency Survey should be incorporated into analyses being performed by Duke Energy to identify the best products and services for Duke Energy's low income customers and to identify homes that have the highest energy savings potential. Data should be integrated in the same database systems (accessed via SQL Server) as home profile data being collected through other Duke Energy programs such as Personalized Energy Report, Online Audit, and Home Energy Comparison Report Pilot.

- **Issue 6:** Duke Energy has recently rolled out a new IVR (Interactive Voice Response) and web-based CFL program that does not include a survey but allows the customer to click a button for a free CFL. This presents a possibility for program overlap as low income customers may obtain the free CFL without completing the Energy Efficiency Survey, or in addition to completing the Energy Efficiency Survey and obtaining the 12 free CFLs. Another potential point of overlap is in the targeted reach of the Home Energy Comparison Reports (HECR), where approximately 10% of HECR customers meet the poverty level requirement.

  Recommendation 6: Duke Energy should monitor for program overlap between these programs. TecMarket Works does not expect there to be significant overlap between the Low Income and IVR programs unless there's a process in place that sends the low income customer to the IVR web program for the free CFL. Significant levels of overlap are not expected because low income customers are less likely to explore non-low-income services on their energy provider's website. However, it's possible that these multiple points of potential contact through these multiple programs could provide additional synergy and savings beyond what the programs deliver independently. Duke Energy should track this possible effect and consider how to best attribute programmatic savings.

2009 Residential Smart $aver Process (Exhibit H)

This evaluation report was finalized on October 3, 2011 and revised on November 21, 2011. The full report is filed as "**Exhibit H - Carolinas - Residential Smart $aver - Final Process Evaluation Report - revised Nov 21 2011**".

Significant Process Evaluation Findings

- The overall participant satisfaction with the program is high at 8.9 on a one-to-ten scale.
- Surveyed program participants cited general advertising and increased incentive as the two most effective ways to increase participation in the Residential Smart $aver® program.
- The majority (64%) of surveyed participants indicated that they were replacing equipment that had failed or was very near the end of its effective useful life.
- The trade allies would like to have the residential program application process available using a Web browser. This would make the program operate more smoothly for both Duke Energy staff and the Residential Smart $aver® partnering trade allies and would speed accessibility to the participation process and eliminate problems with obtaining or printing hard-copy application forms and transmitting them via fax or scanned email.
- The trade allies would like an increase in collaborative marketing between Duke Energy and the trade allies to raise awareness of the program. To achieve this they suggested that Duke Energy provide more literature on the program directly to their customers, to the trade allies, and to provide co-branded (between Duke Energy and the specific trade ally) literature to customers using contact lists supplied by individual trade allies.
- All trade allies considered the Residential Smart $aver® program an essential sales tool for energy efficient equipment.

Recommendations

- **Early retirement marketing and incentives**: Consider providing incentives for early retirement of equipment that are below existing federal levels. This would enable Duke Energy to continue to improve the penetration of high efficiency HVAC equipment while the HVAC technology advances further beyond existing federal standards. The costs of documenting and verifying early retirement measures are higher than just documenting purchases of higher efficiency equipment. However, because existing federal standards have recently increased, the program management acknowledges that the current Residential Smart $aver® incentives may not be enough to overcome the costs of obtaining higher-than-federal standard efficiencies.
- **Program Management Response:** Residential Smart Saver Program Management believes that the ability to offer an equipment financing option is vital to an early replacement program. Program Management will continue to evaluate the early

retirement market as well as an equipment financing option in an effort to provide incentives to customers who choose to retire their HVAC systems before the end of its useful life. Program Management will also evaluate the value of early retirement as evidenced within the evaluation report (Approx. 31% of units had remaining useful life - 3.9 years on average) and will determine if further incentives would be cost effective.

- **Increased budget allocations**: Consider requesting higher levels of energy efficiency spending from the Commission to help meet program demand, thereby increasing energy savings without harming other programs in the portfolio.

- **Program Management Response:** Program Management is currently evaluating the addition of related measures to the Smart $aver Program. Upon identifying additional measures Program Management will present the desired measures to the Commission. At that time, Program Management will also revise Smart Saver participation and costs estimates and request an appropriate amount of dollars required to manage the program adequately and without harming other programs within the portfolio.

- **Test new technologies:** Consider test piloting the addition of the WECC recommended technologies starting with incentive levels that provide cost effective energy savings from those technologies. These include package heat pump units and mini-split ductless HVAC systems.

- **Program Management Response:** Duke Energy continues to evaluate the ductless AC systems and notes that they are an energy efficient product. The Smart Saver program currently incentives only 'whole-house' systems which generally excludes this technology. Additionally, Duke Energy will continue to evaluate all types of electric water heaters for incorporation into the Smart Saver Program.

2011 Power Manager Process (Exhibit I)

This evaluation report was finalized on November 14, 2011. The full report is filed as "**Exhibit I - Carolinas - Power Manager - Final Process Evaluation Report - Nov 14 2011**".

Summary of Findings

Customer Satisfaction

- Satisfaction with the Power Manager® program is high with over half of the survey respondents in both states rating their satisfaction at 9 or 10 on a 10-point scale for all program aspects including overall program satisfaction, as well as satisfaction with program enrollment, and program information.

Motivating Factors

- Three-quarters of the full participant survey respondents (n=49 in North Carolina and N=59 in South Carolina) were able to recall at least one benefit promoted by the program. In addition, the surveyed participants that recalled program benefits were able to provide 147 benefits (1.4 each) they recalled being promoted by the program. Of the 147 benefits recalled by these participants, 65% of them mentioned financial benefits either by recalling the bill credits or financial incentives for participating in the Power Manager® program.

- Most participants rate environmental issues as important or very important to their participation. About 6 percent of respondents in North Carolina and 8 percent of respondents in South Carolina are members of an organization with an environmental mission.

- Many (50% in North Carolina and 59% in South Carolina) of the participants do not recall whether control events occurred since they joined the program. Ninety-three percent of participants across both states did not notice the bill credits on their bill.

- Financial benefit is the most commonly recalled benefit (65% in both states) of the program as well as the most cited reason (58.6% in North Carolina and 66.1% in South Carolina) for participation.

Survey Findings

- The majority of participants (55% in both states) that are at home during a Power Manager activation event, experienced no change in comfort during the event.

- Ten percent of participants, who indicated that they were at home during an event, stated that they had noticed no Power Manager activation had occurred in the past seven days. Forty percent of event participants indicated they had noticed an activation, and 50 percent were unsure of whether an activation had occurred or not.

- Thirty percent of participants across both states contacted after a hot day without a Power Manager event stated that they thought an activation event had occurred in the past seven days even though no event had actually occurred. Twenty percent of these "non-event" participants were correct in thinking that no Power Manager activation had occurred, and 50 percent were unsure of whether an activation had occurred or not.

- The age of air conditioner appears to be the most influential driver of perceived comfort change during a Power Manager activation.

- Two participants (5.7%) in South Carolina who experienced a change in comfort during a Power Manager control event reported using auxiliary or room air conditioners to compensate for the reduced cooling capacity of the central air conditioner during an event. Additionally, 31% reported using a fan during the control events to help maintain comfort levels, while 37% of the respondents report using a fan during non-event hot days during typical control time frames.

- Customers are comfortable in their home with their air conditioners on, and do not experience any significant change in comfort regardless of if there is a control event or not, or the degree of external temperature. There is no evidence of any correlation between high temperature (or heat index) and changes in comfort on days with Power Manager events.

Recommendations

- Consider using Home Energy House Call and Residential Smart $aver® as a lead generation tools for new Power Manager enrollees so that participants in these programs have the opportunity to learn about and request participation in Power Manager. During these efforts, HEHC audits can examine the AC unit and determine if it is a good candidate for Power Manager before informing customers. Likewise, Residential Smart $aver can serve as a lead tool by forwarding rebate information for new AC units to Power Manager marketing managers. These managers can then have contact information identifying customers who are predisposed to want to take energy efficiency actions in their home.

- If Duke Energy is interested in determining whether a new customer has the capacity to reduce by 1.3 kW, Duke Energy should consider having the installation technician gather additional information about the customer's AC units at the time of the switch installation and set participation conditions based on their housing observations. For homes with "smart-meters", Duke Energy could establish assessment algorithms that test the load swings during hot periods and establish a 1.3kW participation threshold.

2010 Home Energy Comparison Report Process and Impact (Exhibit J)

This evaluation report was finalized on November 8, 2011. The full report is filed as "**Exhibit J - Carolinas - HECR - Final Process and Impact Evaluation Report - Nov 8 2011**".

Key Findings: Customer Survey

- There were 305 customers successfully contacted for the survey. Of these, 262 (85.9%) recalled receiving the HECR report.
    - See section titled "Introduction" on page 19.
- 97.7% of the customers who recall the HECR are reading the report. If the full number of contacted customers are included in this calculation (n=305, as noted above), and the assumption is that they throw the HECR away, this brings the percent of customers reading the HECR down to 84.5% of the targeted customers.
    - See section titled "Customers Who Read the HECR and Why" on page 19.
- Before being asked about what messages or tips customers recalled from the HECR, most surveyed customers that read the report defined energy efficiency in simple terms (n=228, or 87.0%), saying "Being energy efficient means saving money" or "use the least amount of energy necessary", while some provided specific examples of what should be done to be energy efficient, such as "Using insulation and weather-stripping " and "Lowering the thermostat " (n=27, or 10.3%).
    - See section titled "Customer Opinions and Actions Regarding Energy Efficiency" on page 20.
- On average, surveyed HECR customers scored their interest in energy efficiency at a higher score than their interest in reading the HECR, unless they thought that they do less than others do to save energy. This finding is statistically significant with 95% confidence.
    - See section titled "Interest in the Energy Efficiency and the HECR" on page 24.
- About 80% of the customers overall are happy with how frequently they receive the HECR, although those that receive the HECR on a monthly basis indicate a higher level of interest in reading the next HECR, which may indicate that those reading the HECR monthly are more engaged with the HECR and therefore more interested in the HECR overall.
    - See section titled "Frequency of the HECR" on page 24.
- HECR customers' satisfaction with the HECR report does not vary significantly between those getting the Line Graph version and those getting the Index Table version. Overall satisfaction scores are high, with the most satisfaction with the reports being easy to read and understand, and with the graphics being helpful to them in understanding how their energy usage changes over the seasons.

- See section titled "Satisfaction with HECR" on page 32.

Recommendations

- If the HECR is deployed as a fully-commercialized program, continue to refine the presentation of the comparison data through monitoring customer responses and leveraging customer surveys. Determine through these and other low-cost methods how usage data can be presented most clearly to customers. Duke Energy should keep in mind that more information is not necessarily better, and that if the desired understanding of social norms of energy use can be achieved with one calculated number, that may be enough.
  - See section titled "HECR Report" on page 14.

- Duke Energy should continually refine their selection of tips and facts to be conveyed in the HECR report. While tips directly aimed at energy savings are necessary to supplement social norm messaging, it may be useful to include other relevant and interesting facts so that customers continue to be engaged and interested. However, all messaging should be targeted at getting customers to reduce their energy use via behavior change or through technology replacement. Messages that move away from this objective can reduce the impact of all messaging and reduce program savings. Likewise, while messaging to cross-sell other Duke Energy programs is necessary to achieve the second of HECR's stated objectives, Duke Energy may need to take care not to oversell the programs, or push programs to customers who are not suitable participants. In order to determine whether customers are indeed interested and engaged versus over-saturated and numbed, Duke Energy should conduct periodic customer status surveys about these and other issues and continue to data mine the programmatic tracking systems to maximize portfolio savings.
  - See section titled "Other Report Content" on page 15.

- If cross-selling remains an objective of the HECR product at scale, then Duke Energy should formally establish a process to assess the effectiveness of HECR as a lead generation mechanism.
  - See section titled "Results" on page 17.

- Add CFL coupons to the HECR mailing if it can be shown that the participants can use additional CFLs that they are not likely to purchase on their own.
  - See section titled "Conclusions and Recommendations for Program Changes" on page 39.

- The impact evaluation discovered that as a customer's average usage increases, the level of savings from HECR also increases (see the table on the next page). Therefore, the program should target high usage customers to achieve the highest energy savings per participant using advanced segmentation analysis methods.
  - See Table 1 on page 5.

Impact Summary Tables

The energy impacts associated with the program were determined by a billing analysis using both customers that received the HECR report (the treatment group) as well as a group of customers who did not (the control group). The billing analysis relies upon a statistical analysis of actual customer-billed electricity consumption before and after the HECR treatment period. The billing analysis used consumption data from all HECR treatment customers in South Carolina (8,258 treatment customers, 4,132 received a monthly report and 4,126 received a quarterly report). A panel model specification was used that incorporated the monthly billed energy use across time and customers. The model included standard statistical procedures to control for the effect of weather on usage, as well as a complete set of monthly indicator variables to capture the effects of non-measureable factors that vary over time (such as economic conditions and season loads).

Table 10 presents the billing data analysis estimate of the impact of the HECR program. It was observed that the impacts vary significantly depending upon the average usage of the customer, so in addition to estimating the overall impact of HECR[8], we developed estimates based upon the average usage of the customer as well as the frequency of the report (monthly or quarterly) and type (Index versus Line).

Table 10. Usage Level and Annual Savings Summary

Usage Level	Annual kWh Per Participant Savings	T-Value
Overall	**147 kWh**	**5.59**
daily use <20 kWh	41 kWh	1.07
daily use >=20 but <30 kWh	32 kWh	0.81
daily use >=30 but <40 kWh	173 kWh	3.71
daily use >=40 but <50 kWh	53 kWh	0.98
daily use >=50 but <60 kWh	233 kWh	3.18
daily use >=60 but <70 kWh	160 kWh	1.49
daily use >=70 but <80 kWh	225 kWh	1.39
daily use >=80 but <90 kWh	288 kWh	1.09
daily use >=90 kWh	443 kWh	1.53

Table 11. Annual Savings by Report Frequency and Type

Report Frequency	Report Type	Annual kWh Per Participant Savings	t-value
Monthly	Line	211	4.42
	Index	229	4.82
Quarterly	Line	70	1.48
	Index	77	1.59

[8] The overall savings was determined by estimating the model over all customers, irrespective of their usage group. Therefore, it captures the proportion of customers in each group, the savings of that group, and also the variability of savings in each group. Therefore, it need not equal the population weighted average savings by usage group.

These results show that overall, the HECR program results in statistically significant savings of 147 kWh/year per customer. In addition, when looking at this by the average (pre-program) usage of the customer, there are a few customer groups that do not show any statistically significant change in usage, while there are other groups, at both the highest usage and lowest usage range that show significant savings. Indicating that annual consumption alone may not be the sole driver of impacts and other demographics can be explored to target maximized savings.

2010 Non-Residential Smart $aver Prescriptive Report Process and Impact (Exhibit K)

This evaluation report was finalized on February 26, 2011 and filed in E7 Sub 979 of March 2011, then revised on June 16, 2011. The full revised report is filed as "**Exhibit K - Carolinas - Non Res Smart $aver Prescriptive - Final Process and Impact Evaluation Report - revised June 16 2011**".

Significant Process Evaluation Findings

- The trade allies and commercial customers would like to have the prescriptive program application process available online. This would make the program operate more smoothly for both Duke Energy staff and the Smart $aver® partnering trade allies and would speed accessibility to the participation process and eliminate problems with obtaining hard-copy application forms and transmitting them via fax.

- The trade allies would like an increase in collaborative marketing between Duke Energy and the trade allies to raise awareness of the program. To achieve this they suggested that Duke Energy provide more literature on the program to the trade allies and to a list of targeted contacts supplied by trade allies. Several trade allies also would like to see Duke Energy initiate a preferred vendor program for the Non-Residential Smart $aver® Program.

Significant Impact Evaluation Findings

- Even though these algorithms are not the source of record for program impact calculations, the measure savings algorithms in the third-party program tracking database contain errors. Program accomplishments should be tracked using measure counts from the program tracking database and unit energy savings from program design calculations contained within DSMore until the errors can be corrected. Duke Energy was aware of this problem, and steps will be taken to correct this issue.

- Customer self-reported fixture watts for new and replaced fixtures are inconsistently reported and proving to be unreliable. We suggest removing this information from the applications to reduce customer burden.

- Energy and demand savings realization rates for kWh and kW for high bay lighting were very close to 1.0, indicating the program planning estimates provide a good indication of average high bay lighting participant savings.

A summary of the impact findings is presented in the standardized Duke Energy Program Impact Metrics Tables below. Table ES-3 presents total fixtures across both states as well as weighted averages for the "per fixture" savings metrics. North and South Carolina are weighted at 65% and 35% respectively. This distribution reflects the quantity of fixtures in each state as compared to the total from both.

Table ES-1 Program Impact Metrics Summary for North Carolina

Metric	Result
Number of Program Participants from 6-1-2009 to 4-30-2010	23,600 fixtures
Gross kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.098
High Bay 3L T-5 High Output	0.148
High Bay 4L T-5 High Output	0.307
High Bay 6L T-5 High Output	0.147
High Bay 8L T-5 High Output	0.498
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.197
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.318
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.214
Gross kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	578
High Bay 3L T-5 High Output	867
High Bay 4L T-5 High Output	1,799
High Bay 6L T-5 High Output	859
High Bay 8L T-5 High Output	2,924
High Bay Fluorescent 4 Lamp (F32 Watt T8)	1,157
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,863
High Bay Fluorescent 8 Lamp (F32 Watt T8)	1,253
Gross therms per fixture	N/A
Freeridership rate	30%
Spillover rate	
Self Selection and False Response rate	
Total Discounting to be applied to Gross values	30%
Net kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.069
High Bay 3L T-5 High Output	0.104
High Bay 4L T-5 High Output	0.215
High Bay 6L T-5 High Output	0.103
High Bay 8L T-5 High Output	0.349
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.138
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.223
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.150
Net kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	405
High Bay 3L T-5 High Output	607
High Bay 4L T-5 High Output	1,259
High Bay 6L T-5 High Output	601
High Bay 8L T-5 High Output	2,047
High Bay Fluorescent 4 Lamp (F32 Watt T8)	810
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,304
High Bay Fluorescent 8 Lamp (F32 Watt T8)	877
Net therms per fixture	N/A
Measure Life	10

Table ES-2 Program Impact Metrics Summary for South Carolina

Metric	Result
Number of Program Participants from 6-1-2009 to 4-30-2010	12,615 fixtures
Gross kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.088

Metric	Result
High Bay 3L T-5 High Output	0.132
High Bay 4L T-5 High Output	0.274
High Bay 6L T-5 High Output	0.131
High Bay 8L T-5 High Output	0.446
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.176
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.284
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.191
Gross kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	530
High Bay 3L T-5 High Output	795
High Bay 4L T-5 High Output	1,650
High Bay 6L T-5 High Output	788
High Bay 8L T-5 High Output	2,681
High Bay Fluorescent 4 Lamp (F32 Watt T8)	1,060
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,709
High Bay Fluorescent 8 Lamp (F32 Watt T8)	1,149
Gross therms per fixture	N/A
Freeridership rate	30%
Spillover rate	
Self Selection and False Response rate	
Total Discounting to be applied to Gross values	30%
Net kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.062
High Bay 3L T-5 High Output	0.092
High Bay 4L T-5 High Output	0.192
High Bay 6L T-5 High Output	0.092
High Bay 8L T-5 High Output	0.312
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.123
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.199
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.134
Net kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	371
High Bay 3L T-5 High Output	557
High Bay 4L T-5 High Output	1,155
High Bay 6L T-5 High Output	552
High Bay 8L T-5 High Output	1,877
High Bay Fluorescent 4 Lamp (F32 Watt T8)	742
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,196
High Bay Fluorescent 8 Lamp (F32 Watt T8)	804
Net therms per fixture	N/A
Measure Life	10

Table ES-3 Program Impact Metrics Summary for North and South Carolina

Metric	Result
Number of Program Participants from 6-1-2009 to 4-30-2010	36,215 fixtures
Gross kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.095
High Bay 3L T-5 High Output	0.143
High Bay 4L T-5 High Output	0.296
High Bay 6L T-5 High Output	0.141
High Bay 8L T-5 High Output	0.481

Metric	Result
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.190
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.306
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.206
Gross kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	561
High Bay 3L T-5 High Output	843
High Bay 4L T-5 High Output	1748
High Bay 6L T-5 High Output	835
High Bay 8L T-5 High Output	2842
High Bay Fluorescent 4 Lamp (F32 Watt T8)	1124
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1811
High Bay Fluorescent 8 Lamp (F32 Watt T8)	1218
Gross therms per fixture	N/A
Freeridership rate	30%
Spillover rate	
Self Selection and False Response rate	
Total Discounting to be applied to Gross values	30%
Net kW per fixture	kW/fixture
High Bay 2L T-5 High Output	0.067
High Bay 3L T-5 High Output	0.100
High Bay 4L T-5 High Output	0.207
High Bay 6L T-5 High Output	0.099
High Bay 8L T-5 High Output	0.337
High Bay Fluorescent 4 Lamp (F32 Watt T8)	0.133
High Bay Fluorescent 6 Lamp (F32 Watt T8)	0.214
High Bay Fluorescent 8 Lamp (F32 Watt T8)	0.144
Net kWh per fixture	kWh/fixture
High Bay 2L T-5 High Output	393
High Bay 3L T-5 High Output	590
High Bay 4L T-5 High Output	1,224
High Bay 6L T-5 High Output	585
High Bay 8L T-5 High Output	1,989
High Bay Fluorescent 4 Lamp (F32 Watt T8)	787
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,268
High Bay Fluorescent 8 Lamp (F32 Watt T8)	853
Net therms per fixture	N/A
Measure Life	10

Recommendations

1. Evaluate the usefulness of a possible training webinar. Consider recording a webinar for future web access. A webinar may prove to be a benefit only if it is offered live, with a live question and answer period.

2. Explore the effectiveness of email and electronic campaigns and survey trade allies to determine the frequency with which they prefer to be contacted. Reports from the field suggest that trade allies may prefer the less-expensive email campaigns over mailed materials. This may allow the Non Res Smart $aver® to have a broader reach at a lower cost.

3. Duke Energy should consider the feasibility of providing more case studies on customers who have implemented energy efficiency projects using high-priority high-impact measures in program materials provided to trade allies for them to share with their customers. Duke Energy may wish to include case studies on customers from several market segments. If built correctly, such case studies would increase the understanding of the Smart $aver® program by customers in different market segments because they would have examples to which they can relate, lowering the perceived risk and uncertainty for new participants.

4. Duke Energy should explore the feasibility of developing a coordinated marketing campaign for one market segment, implementing it as a pilot, and evaluating its effectiveness. A small pilot would allow Duke Energy to assess whether targeting marketing to one segment would be a more effective approach for future program efforts.

5. Duke Energy and WECC should jointly share and discuss their technology selection processes. This would allow both parties to better provide feedback in order to make accurate estimates of market activity. This would also allow both Duke Energy and WECC to explain, if the trade allies ask, why certain technologies are not included.

6. WECC should provide timely feedback to Duke Energy about whether they believe the projected market activity levels provided by Duke Energy are realistic, based upon WECC's experience in the field. This would allow Duke Energy to use WECC's direct experience in the field to relay any upcoming customer purchasing trends.

7. If poor economic conditions are expected to impact customers' ability to take on retrofit projects, and if there is enough spread among the energy efficiency levels of equipment available to make offering multiple levels of efficiency a viable option, Duke Energy should assess whether it is feasible to test a tiered prescriptive program that would allow customers to still install energy efficient technologies when the highest efficiency models are priced out of their current means. However, Duke Energy should not trade off higher levels of free ridership in exchange for increased participation in a program that achieves lower levels of energy savings. It is possible that cost per achieved net kWh would be increased under such an offer depending on how the market would respond.

8. Explore whether it is feasible to create marketing and outreach campaigns that focus on lifecycle costs. This may allow customers to look beyond consideration about a measure's capital cost and its incentive, and understand the energy savings that would be delivered over the measure's effective useful life.

9. Make the template for itemizing invoices available online. This guidance would allow trade allies and customers to send in more accurate applications that would be rejected less frequently and could be processed more quickly and cost effectively, without WECC needing to contact applicants for missing information.

10. Duke Energy should consider conducting usability studies and satisfaction surveys of the online application process. This may allow Duke Energy to quantify any reduction in application speed and any increase in customer satisfaction with the application process.

11. Duke Energy should consider the feasibility of designing, implementing, and evaluating a pilot program to help <500 kW customers to prioritize energy efficient projects. This may allow more Duke Energy customers to achieve greater savings by providing them with a more complete picture of their energy efficiency options.

12. Duke Energy should consider the potential benefits of increased market segment penetration if marketing were structured to specifically focus on barriers for a particular key market segment. Duke Energy may want to do this by identifying one high priority market and conducting a characterization study about that market. Duke Energy might then identify that market's specific barriers to participation and develop a logic model that specifies a strategic approach toward overcoming those barriers. Duke Energy can then evaluate the effectiveness of the approach at the end of the program cycle. This would allow Duke Energy to see if they would be able to successfully drive greater activity in a particular segment if there arose a need for doing so in the future.

2010 Non-Residential Energy Assessments Report Process and Impact (Exhibit L)

This evaluation report was finalized on October 24, 2011. The full report is filed as "**Exhibit L - Carolinas - Non-Res Energy Assessment - Final Process and Impact Evaluation Report - Oct 24 2011**".

Program Operations: Recommendations

1. RECOMMENDATION: The Non-Residential Energy Assessments Program (EAP) should work with the Account Managers to develop clear criteria for identifying prospective participants for the Smart $aver® program based upon segmentation of past Smart $aver® participants. An analysis of what projects and measures were of interest to past Smart $aver® participants in each industry sector would allow Account Managers to make suggestions of similar projects to prospective participants in the same sector. This would allow the budget for the EAP to be directed to those customers who are more likely to take action.
2. RECOMMENDATION: Track the conversion rate (i.e. percentage of EAP participants who adopt EAP recommendations through subsequent Smart $aver® projects) and identify those Account Managers who are more successful at actively converting EAP participants into Smart Saver® participants. These Account Managers may have developed successful strategies that could be shared with other Account Managers to help them increase Duke Energy's overall conversion rates from EAP to Smart $aver®.
3. RECOMMENDATION: The results from the survey of participants indicates that customers are looking for a more comprehensive, more investigative assessment that focuses on new items that they are not already considering. The next evaluation of this program should include a more focused effort on understanding what participants expect to see from the service and the quality of the services expected. That assessment should also focus on understanding the customer's needs associated with short term versus long term recommendations and in terms of electric-only versus more comprehensive sustainability recommendations. While the primary objective is to help customers identify projects that can be implemented under the Smart $aver® program, the overall credibility of energy efficiency-related recommendations may be enhanced by including recommendations that present a more comprehensive approach to reducing operating costs. Depending upon the survey results, Duke Energy may also elect to design additional assessment offerings, such as a "zero net energy assessment" or other high savings assessments (not just those recommendations that are cost effective for Duke Energy) for those customers who are motivated to achieve deep energy savings. This would help maintain Duke Energy's standing as the customers' primary partner in meeting all their energy needs, including any need to explore sustainable energy options for their company.
4. RECOMMENDATION: Tailor the report to provide recommendations that are targeted to the specific needs of different commercial market segments. This will allow Duke Energy to show customers that their needs are understood, and that the assessment report's recommendations are customized especially for them. Duke Energy can begin to

develop these targeted recommendations by first asking Account Managers to identify a few key market sectors that they believe have the greatest untapped potential for energy savings. Duke Energy can survey the Smart $aver® participants and non-participants within those sectors to determine their needs, wants, barriers to participation, and how well the Smart $aver® program addresses those. If Duke Energy has not already done so, we recommend that Duke Energy also conduct market characterization studies for those sectors to see what the mid- to long-term energy-use related trends are for that market, and also to aid in their conversations with the customers about the projects with longer paybacks. Information from the surveys and any market characterization studies can also be used to build case studies that will help other customers understand the process and benefits of participating in Smart $aver®.

5. RECOMMENDATION: The next evaluation should also look deeper into the value associated with providing recommendations for low-cost and no-cost savings in addition to the Energy Assessment recommendations for projects. Likewise, the evaluation should conduct some contingency analyses of a broader set of recommendations-adoption data to determine whether adopting low-cost and no-cost recommendations affect the adoption of Smart $aver®-eligible measures. In a parallel study, the assessment should investigate whether there are any corollary benefits to including low-cost and no-cost recommendations. For example, excluding low-cost and no-cost recommendations may inadvertently emphasize the greater expense of the Smart $aver®-eligible measures, and thus increase the perceived first-cost barriers to becoming more energy efficient.
6. RECOMMENDATION: EAP should use the program's follow up activities to obtain immediate feedback on the usefulness of the assessment reports. This may allow a better leveraging of resources. Additionally, if Account Managers are conducting the follow up feedback, the program's Smart $aver® objectives and services can be kept at the forefront of customer interactions.
7. RECOMMENDATION: Develop the program website so that it is easy to find on the web, has a clear presentation of the services offered and the service approach, and an easy to use web-based enrollment process.
8. RECOMMENDATION: Design the assessment to formally provide low-cost and no-cost recommendations to customers and incorporate estimates of the impact of these actions, when implemented into the tally of energy saved credited to Duke Energy (and other utilities) as a result of the program. The low-cost and no-cost savings may not be eligible for cost recovery, but it is important to document the full value of the EAP, whether officially credited or not. This will allow Duke Energy to make decisions with a more comprehensive knowledge of how each energy efficiency program interacts with the other programs in Duke Energy's energy efficiency portfolio.

Implementation Rates: Key Findings

1. **Many Recommendations are Accepted and Used:** Fifteen facilities; including thirteen receiving offsite assessments, and two receiving onsite assessments, were provided with a total of 94 recommendations:

- The overall implementation rate for all recommended measures was 16.8%.
- 49.5% of the recommendations were rejected by the customer and will not be implemented.
- 11.6% of recommended measures were installed prior to receiving the report
- 12.6% of recommended measures are planned for the future

2. **Participants Take Action Rapidly:** Of the recommendations that were implemented prior to the independent evaluation survey, 64% were completed within six months of receiving the report. 50% were completed immediately upon receipt of the recommendation or within the following 30 days.

3. **Economy and Corporate Conditions Slow Measure Installations:** Corporate economic conditions and the firm's current financial status together represent the most common reasons provided for a recommended measure not being implemented. These two reasons are similar in that they deal with the firm's financial condition within the economies in which they operate. As a result, measures with long payback periods and/or excessive upfront capital costs become the measures cited most often as those that cannot be implemented.

Program Satisfaction: Key Findings

1. **Satisfaction scores show room for improvement:** Participants gave the three highest satisfaction scores to "Ease of Requesting Assessment," "Convenience of Scheduling Report" and "Clarity and Ease of Understanding Report" which received satisfaction ratings of 8.5 or higher on a ten point scale. However, no category had an average score of more than 8.8, and two categories ("Length of Time to Receive Assessment" and "Practicality of the Recommendations Provided") were given ratings of seven or less more than 50% of the time.

2. **Assessment report delays and practicality of report are concerns:** Five participants noted that they encountered delays in receiving their assessment. The briefest delay mentioned was two weeks. Eight of fifteen participants rated the overall practicality of the report at less than eight, and one participant stated that he implemented zero recommendations directly as a result of the lack of practicality.

Engineering Impact Estimates: Key Findings

There were a total of 201 customers in the Carolinas that received an energy assessment. Fifteen of the 201 customers were interviewed for this evaluation. Of the 15 interviewed, 7 were able to verify the actions implemented as a result of the assessment report[9]. The energy saving measures taken by these seven customers as a result of the program provide gross annual savings

[9] Because the primary purpose of this study is the process evaluation, the sample of customers interviewed is too small for programmatic energy impacts to be estimated. However, the impact analysis provides a sample of the types of projects and the level of energy savings than can be expected from those customers who take the recommended actions.

of 8,663,381 kWh, -23,904 MMBtu, and reduction of peak load by 882 kW. A breakdown of the savings by customer can be seen in Table 12.

Table 12. Program Savings Estimate Breakdown by Customer (Excludes Smart $aver® Incentives)*

Customer	kWh	kW	MMBtu
Customer One	764,422	72.7	-2,140
Customer Two*	0	0.0	0
Customer Three	4,159	0.0	0
Customer Four	8,779	4.5	-25
Customer Five	64,696	0.0	0
Customer Six	11,777	0	0
Customer Seven	45,492	0.0	0
TOTAL	**899,324**	**77.1**	**-2,165**

*Customer Two completed a lighting retrofit, achieving gross annual savings of 7,764,057 kWh and reducing peak load by 805 kW. The retrofit was advised through the Energy Assessment program, but facilitated by the Prescriptive Smart $aver® program, through which this customer received a rebate for both the fixtures and the accompanying occupancy sensors. All savings achieved by this customer has been attributed to the Prescriptive Smart $aver® program and is therefore not counted toward the Energy Assessment's total savings represented in Table 12.

Table 13 shows all of the measures that contribute to program savings and the number of customers that implemented them. The table also details gross savings as well as per unit savings broken down by measure.

Table 13. Summary of Program Savings by Measure

Measure	Participation Count	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Gross Ex Ante kWh Savings	Gross Ex Ante kW Savings
Lighting: Metal Halide to HO T8	2	1,634	0.156	764,910	73.13
Lighting: Metal Halide to T5 and Occupancy Sensors	1	2,810	0.291	7,764,057	804.7
Exhaust Hood Fan Controls	1	4,159	0.000	4,159	0.000
Lighting: Hg Vapor to T8	1	63.77	0.061	446.4	0.425
Lighting: T12 to T8	1	326.8	0.150	7,844	3.590
Compressed Air System Repair and Maintenance Program	1	64,696	0.000	64,696	0.000
Control System for Tenter Frame Exhaust	1	11,777	0.000	11,777	0.000
Compressed Air System Leak Check Program	1	45,492	0.000	45,492	0.000

2010 Non-Residential Smart $aver Custom Report Process (Exhibit M)

This evaluation report was finalized on August 12, 2011. The full report is filed as "**Exhibit M - Carolinas - Non-Res Smart $aver Custom - Final Process Evaluation Report - Aug 12 2011**".

Significant Process Evaluation Findings

Duke Energy's Smart $aver® Custom program is playing an important role in helping non-residential customers to implement projects using measures not in the Smart $aver® Prescriptive program. The program is also being marketed very well, through a network of dealers and distributors, as well as through Duke Energy's account managers. While all customers appreciate that Duke Energy offers a Custom program, they are only moderately satisfied with the program. Two areas where customers express less satisfaction are in the application's difficulty and in the time for application review. Duke Energy's Smart $aver® Custom program managers are well aware of the challenges facing their program, and have already taken steps to address them. Smaller customers find that the application is difficult if the applicant does not have a technical or engineering background. Duke Energy's program managers report that the time to review larger project applications is only marginally greater than the time to review smaller project applications. They also report that while the program's overall success depends critically on those larger projects, they are expending the majority of their resources on reviewing the smaller applications. As it is right now, the Smart $aver® Custom program may have reached a point of equilibrium, with the difficulty of the application process serving to reduce the number of applications from the smaller projects.

Recommendations

1. Duke Energy should decide what size projects (in terms of energy savings) the Custom program should target. Duke Energy program managers have expressed a greater need to encourage larger projects, in order to increase program effectiveness. Duke Energy may determine that it is not cost prohibitive to provide technical support for all the "onesie, twosie" projects. Whether or not Duke Energy decides to support projects of all sizes, making an explicit decision one way or the other may allow Duke Energy to allocate their resources and outreach more efficiently.
2. If Duke Energy decides to continue to encourage customers with smaller projects to apply, Duke Energy should find a way to provide technical support to qualified unassigned customers who are filling out their own applications. Alternately, Duke Energy may also want to consider temporarily assigning those customers to a Duke Energy representative, or temporarily requesting technical assistance from WECC to meet those unassigned customers' needs. This would allow those smaller customers to receive the assistance they say they need.
3. Duke Energy should also consider managing all customers' expectations for the amount of work involved in filling out an application, and perhaps provide data on what types of projects had been approved in the past. This may allow customers to make more informed choices on whether it is worthwhile for them to undertake the work of applying.

Low Income Memo on Freeridership (Exhibit N)

This evaluation memo was sent on August 12, 2011. The full memo is filed as "**Exhibit N - Low Income Program Freeridership - Memo - July 11 2011**". The summary of the memo is below, with supporting documentation included in Exhibit N.

Typically low income evaluation studies indicate zero to very low freeridership levels for CFLs.

Studies have found that low-income households do not typically purchase CFLs but tend to acquire the ones they have via utility programs, social programs, low-income support efforts, and promotional giveaways. The price of a CFL is still substantially higher than standard bulbs and represents a cost barrier for low income populations.

As a result, the NTG ratio used for low-income programs is typically around 1.0, suggesting few freeriders associated with energy program acquired CFLs.

2009 Residential Smart $aver Impact (Exhibit O)

This evaluation report was finalized on January 27, 2012 . The full report is filed as "**Exhibit O - Carolinas - Residential Smart $aver - Final Impact Evaluation Report – Jan 27 2012**".

Significant Impact Evaluation Findings[10]

Table 14 presents the gross unit kWh and kW savings per ton associated with the Residential Smart $aver program. These results are obtained based on a model which uses the results of the engineering analysis within a statistical billing data analysis (the SAE approach).

Table 14. Energy Savings Per Ton Associated with the Residential Smart $aver Program in the Carolinas

Asheville NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	222	0.110	-5
AC_seer15	270	0.120	-6
AC_seer16	285	0.090	-6
AC_seer17	305	0.120	-6
Hp_seer14	399	0.100	0
Hp_seer15	372	0.130	0
Hp_seer16	422	0.167	0
Hp_seer17	245	0.170	0
Hp_seer18	447	0.180	0

Charlotte NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	244	0.150	-4
AC_seer15	301	0.140	-4
AC_seer16	335	0.110	-5

10 Because the price of the program-covered equipment is presented to the customer after the dealer has already deducted the Duke Energy incentive from their sales price, the customer is typically not aware that the price being quoted is a function of the application of the Duke Energy rebate. Under these conditions, the customers' self-reported impacts of the program's incentive are not able to be estimated by the customer making the purchase. As a result, TecMarket Works considers the results of the freerider assessment within the participant survey to be unreliable for the purposes of estimating net energy impacts. For the purposes of the impact evaluation, TecMarket Works sets the program-level freeridership at the mid-point of the values estimated by the interviewed dealers. That value is 27.5%. As a result of this estimate, TecMarket Works finds that 72.5% of the units sold were caused by or substantially caused by the Duke Energy program and would not have been sold without the program's influence.

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer17	366	0.140	-5
Hp_seer14	343	0.170	0
Hp_seer15	361	0.160	0
Hp_seer16	427	0.190	0
Hp_seer17	314	0.200	0
Hp_seer18	442	0.200	0

Greenville SC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	238	0.110	-4
AC_seer15	290	0.120	-4
AC_seer16	319	0.110	-6
AC_seer17	345	0.140	-6
Hp_seer14	367	0.100	0
Hp_seer15	366	0.140	0
Hp_seer16	429	0.180	0
Hp_seer17	284	0.180	0
Hp_seer18	448	0.190	0

Program participation by HVAC system type, size, SEER, and location were applied to the savings per ton estimates from Table 14 above to compute the program savings, as shown in Table 15.

Table 15. Summary of Program Savings by Measure

Measure	Participation Count	Gross Ex Post kWh Savings	Gross Ex Post kW Savings	Gross Ex Post kWh Savings per unit	Gross Ex Post kW Savings per unit
Air conditioner	6,086	5,053,612	2,149	830	0.353
Heat Pump	13,256	13,220,103	5,821	997	0.439

- The electronically commutated (EC) motors required by the program caused very little change in occupant behavior relative to supply fan usage. Large increases in supply fan operating hours after system installation were not observed. The proportion of fan systems operating continuously decreased slightly after system installation.

- The EC motors provided substantial savings in fan power consumption, on the order of 46%.
- Future evaluation monitoring should also include sites from North and South Carolina if monitoring resources can be provided to this effort. The monitoring should capture fan, compressor and strip heat energy to provide full unit heating and cooling data for model development and calibration.
- Engineering modeling revealed energy and demand savings that are not proportional to the difference in SEER. The SEER, which is based on a standardized laboratory test, is not a reliable predictor of annual energy consumption under the more realistic operating conditions included in the building energy simulation models. Higher SEER air conditioners and heat pumps typically rely on multiple compressors to improve part-load performance, but may not provide proportional improvements in full-load efficiency. The results seen in this evaluation are consistent with results in other states.
- The billing analysis indicates that the participants realized 67% and 56% of the savings estimated by the engineering analysis for air conditioners and heat pumps, respectively. The air conditioner results are consistent with results for the Smart $aver program in other Duke Energy jurisdictions. Heat pumps system monitoring, as described above, is recommended to improve the engineering estimates of heat pump savings in the Carolinas.
- Participating dealers should record the make and model number of the replaced air conditioner and provide an assessment of the condition of the unit as part of the rebate application process. These data will allow the evaluation team to improve the estimate of the early replacement baseline efficiency.

Recommendation

- Duke Energy may wish to consider conducting an economic impact evaluation of key Duke Energy programs, including the Smart $aver Program, as previous studies suggest that job related impacts of energy efficiency programs may be substantial. Previous studies conducted on the economic impacts associated with energy efficiency programs show impacts in four job creation categories. These include: 1) Jobs created by helping businesses become more profitable by lowering their cost of operations, making them more competitive; 2) Lowering the energy cost of living for customers that increases their disposable income, which in turn supports jobs driven by expenditures other than energy; 3) Dollars spent more locally on non-energy expenditures keeps more dollars in the state being re-spent through the local economy creating more in-state jobs; and 4) Greater spending within non-energy economic streams leads to increased manufacturing, distribution and sales that require additional jobs to support consumer demand. Evaluations that assess economic effects of programs allow policy makers to understand a fuller range of program impacts. These evaluations can be conducted using secondary data (research conducted by others and applied to the Duke Energy programs) or use primary research depending on the reliability needs associated with the study findings.

Non-Residential Lighting Additional Lighting Measure Impact Memo (Exhibit P)

This evaluation memo was sent on December 29, 2011. The full memo is filed as "**Exhibit P - Carolinas - Evaluated Savings for 3 Lamp High Bay Fixture - Memo - Dec 29 2011**" and provides an update to the evaluated savings for High-Bay fixtures in the Non-Residential Smart $aver® Prescriptive program as implemented in North and South Carolina.

Non-Residential VFD Measure Impact Memo (Exhibit Q)

This evaluation memo was sent on February 2, 2012. The full memo is filed as "**Exhibit Q - Carolinas - Non-Residential Smart $aver - VFD Update Memo - Feb 2 2012**" and provides an update to the VFD component of the Non-Residential Smart $aver® Prescriptive program evaluation.

Current Evaluation Activities

Energy Efficiency Education Program for Schools

This evaluation is currently in progress. Process evaluation activities began, with onsite activities being conducted in March of 2012. Please see "Planned Evaluation Activities" for tasks and timeline.

Residential Energy Assessments: PER

This evaluation is currently being planned. Please see "Planned Evaluation Activities" for tasks and timeline.

Residential Energy Assessments: HEHC

This evaluation is currently being planned. Please see "Planned Evaluation Activities" for tasks and timeline.

Residential Smart $aver: HVAC

This evaluation is currently being planned. Please see "Planned Evaluation Activities" for tasks and timeline.

Residential Smart $aver: CFLs

This evaluation is currently in progress. Process evaluation activities began, with participant surveys currently being fielded. Please see "Planned Evaluation Activities" for tasks and timeline.

Residential Smart $aver: Property Manager CFLs

This evaluation is currently in progress. Process evaluation activities began, with management and participant survey instruments currently being developed. Please see "Planned Evaluation Activities" for tasks and timeline.

Smart $aver for Non-Residential Customers - Prescriptive Lighting

This evaluation is currently in progress. Impact evaluation sample selection is in progress. Please see "Planned Evaluation Activities" for tasks and timeline.

Smart $aver for Non-Residential Customers - Prescriptive VFDs

This evaluation is currently being planned. Please see "Planned Evaluation Activities" for tasks and timeline.

Smart $aver for Non-Residential Customers - Custom

This evaluation is currently in progress. Impact evaluation sample selection is in progress. Please see "Planned Evaluation Activities" for tasks and timeline.

Planned Evaluation Activities

Appliance Recycling

The program process evaluation will include program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, recall, and satisfaction. The impact evaluation will include an engineering analysis that will incorporate on-site field studies.

EM&V for SC Proposed Appliance Recycling Program

This program is pending approval, therefore the expected start date is tentative.

Expected Start Date*: 3/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis			
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis			
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis			
Process	Analysis and Early Feedback				Analysis			
Process	Process Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Selective monitoring (may not be performed if valid data collected through Process Eval).		sample pulled	Pre/post monitoring of whole HVAC systems. These data will be used to inform the DOE-2 simulation models				
Impact	In Situ Site visits		sample pulled	In situ metering assessment to determine the energy consumption of 140 appliances collected from the home (70 refrigerators and 70 freezers)	Duke staff will conduct site visits at a sample of sites to verify unit installation and gather building characteristics data.			
Impact	Data Cleaning				Data from process evaluations and On site will be analyzed and prepared for the engineering analysis.			
Impact	Engineering Estimates				Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models.			
Impact	Impact Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	3/1/2012						

* Equipment installed, and enough participation for statistically significant results

MyHER (formerly HECR)

The program process evaluation will include program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, recall, and satisfaction. The impact evaluation will include a billing analysis.

EM&V for SC My Home Energy Report — This program is pending approval, therefore the expected start date is tentative.

Expected Start Date: 5/1/2012

		4	6	8	10	12	14	16	18
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis				
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis				
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Billing Analysis						A statistical billing analysis of program participants will be conducted and compared to the engineering estimates		
Impact	**Impact Evaluation Report**							Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	6/1/2013							

Energy Efficiency Education Program for Schools

The process evaluation will include program manager, implementer, school administrator, and teacher interviews to assess program operations, and student family surveys to assess program awareness, satisfaction, and compliance with installations and recommendations. The impact evaluation will consist of engineering estimates and billing analysis.

EM&V for SC Energy Efficiency Education Program for Schools

Expected Start Date*: 11/1/2011

Please note: This program has a later start date than previously planned for because of the changes in the program (changing from Scholastic's teacher kits and curriculum to NTC's presentations)
The later date was set to allow time for program bidding, implementer selection, and program development

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
	Student Family Surveys		Instrument Development	Conduct Surveys	Analysis				
	Interview Program Vendors	Instrument Development	Conduct Surveys with NTC, Teachers, and School Administrators	Analysis					
	Review of NTC Presentation	On-Site Review	Analysis						
	Analysis and Early Feedback			Memo					
	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Engineering Estimates				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.				
	Billing Analysis					A statistical billing analysis of program participants will be conducted and compared to the engineering estimates.			
	Impact Evaluation Report							Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	9/1/2012							

Low Income EE and Weatherization

The process evaluation will include program manager and CAP staff interviews to assess program operations, and participant surveys to assess program satisfaction. The impact evaluation will consist of a billing analysis and engineering estimates.

EM&V for SC Low Income EE and Weatherization — Schedule to be determined by modified program launch date.

Expected Start Date*: 3/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
	Participant Surveys		Instrument Development	Conduct Surveys	Analysis			
	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis			
	Interview Program Vendors and CAP agencies		Instrument Development	Conduct Surveys	Analysis			
	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations	
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Data Cleaning				Data from process evaluations will be analyzed and prepared for the engineering analysis.			
	Engineering				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.			
	Billing Analysis						A statistical billing analysis of program participants will be conducted and compared to the engineering estimates.	
	Impact Evaluation Report							Final Report
	Effective Date of Impacts							

Low Income Neighborhood

The process evaluation will include program manager and CAP staff interviews to assess program operations, and participant surveys to assess program satisfaction. The impact evaluation methodology will be determined after program participation levels are gauged approximately six months after program implementation.

EM&V for SC Low Income Neighborhood

This program is pending approval, therefore the expected start date is tentative.

Expected Start Date*: 3/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis			
	Participant Surveys		Instrument Development	Conduct Surveys	Analysis		
	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis		
	Interview Program Vendors and CAP agencies	Instrument Development	Conduct Surveys	Analysis			
	Analysis and Early Feedback			Memo			
	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14
Impact	The impact evaluation for the Low Income Neighborhood program will be developed after program participation is gauged at a minimum of 6 months following program administration. With sufficienct participants, a billing analysis will be conducted where energy usage for each customer will be analyzed before and after their participation to determine if they have decreased their energy consumption as a result of their participation. If participation is lower than expected, savings estimates based on engineering algorithms and participant surveys can be conducted.		Gauge program participation and determine methodology				
	Impact Evaluation Report						
	Effective Date of Impacts						

* Equipment installed, and enough participation for statistically significant results

Non-Residential Energy Assessments

The 2011 process evaluation will include program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, satisfaction, and compliance with recommendations. The impact evaluation will include engineering estimates and billing analysis.

EM&V for SC Non-Residential Energy Assessments
Expected Start Date:
1/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis				
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Engineering Estimates				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys.				
Impact	Billing Analysis						A statistical billing analysis of program participants will be conducted and compared to the engineering estimates		
Impact	**Impact Evaluation Report**							Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts								

Power Manager

The process evaluation, if conducted, will consist of participant surveys within three days of control events to assess program awareness and satisfaction. The impact evaluation includes operability and A/C cycling studies.

EM&V for SC Power Manager

There is no need to conduct a process evaluation in 2012, but Recency surveys may occur.

Expected Start Date*: 2/1/2012

Months After Program Implementation-->	4	6	8	10	12	14
Participant Recency Surveys (as needed)	Instrument Development	Conduct Surveys	Conduct Surveys	Analysis		
Process Evaluation Report (as needed)					Final Report	Duke reviews and addresses report recommendations

* Equipment installed, and enough participation for statistically significant results

EM&V for SC Power Manager

Expected Start Date*: 2/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Operability Studies (as needed)		field work begins					
	A/C Cycling Study (as needed)		field work begins					
	Impact Analysis				Duke Energy will conduct impact estimates. Time-series framework to estimate baseline energy usage. The interval data will be analyzed to estimate load reductions during control events			
	Impact Analysis Review					TMW Review of Impact Estimates in Impact Report		
	Impact Analysis Report						Final Report	Duke reviews and addresses any memo recommendations
	Effective Date of Impacts							

* Equipment installed, and enough participation for statistically significant results

PowerShare

The process evaluation will not be conducted in 2012. The impact evaluation will be conducted by Duke Energy and reviewed by the evaluation team.

EM&V for SC PowerShare

A process evaluation will not be done in 2012.

Expected Start Date* 1/1/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Impact Analysis Review						Duke Energy will conduct impact estimates		
	Impact Analysis Report							Final Report	Duke reviews and addresses any memo recommendations
	Effective Date of Impacts								

* Equipment installed, and enough participation for statistically significant results

Residential Energy Assessments: PER

The process evaluation will include program manager and implementer interviews to assess program operations, and participant surveys to assess program satisfaction. The impact evaluation will consist of a billing analysis and engineering estimates.

EM&V for SC Residential Energy Assessments: PER

Expected Start Date 11/1/2011

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis			
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis			
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations	
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Engineering Estimates				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.			
Impact	Billing Analysis				A statistical billing analysis of program participants will be conducted and compared to the engineering estimates.			
Impact	**Impact Evaluation Report**						Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	7/1/2012						

Residential Energy Assessments: HEHC

The process evaluation will include program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness and satisfaction. The impact evaluation will consist of a billing analysis and engineering estimates.

EM&V for SC Residential Energy Assessments: HEHC
Expected Start Date
11/1/2011

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
Process	Participant Surveys	Instrument Development	Conduct Surveys	Conduct Surveys	Analysis			
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis			
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations	
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Engineering Estimates				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.			
Impact	Billing Analysis				A statistical billing analysis of program participants will be conducted and compared to the engineering estimates.			
Impact	**Impact Evaluation Report**						Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	6/1/2012						

Residential Smart $aver: HVAC

The process evaluation will include program manager and implementer interviews to assess program operations, participant surveys to assess program awareness, satisfaction, equipment replacement, and end-use persistence. The impact evaluation will include a billing analysis, and an engineering walk through, short term monitoring, building simulation modeling as appropriate.

EM&V for SC Residential Smart $aver: HVAC

Expected Start Date*
7/1/2011

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis				
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis				
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis				
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Selective monitoring					Pre/post monitoring of whole HVAC systems. These data will be used to inform the DOE-2 simulation models.			
Impact	Site visits					Duke staff will conduct site visits at a sample of sites to verify unit installation and gather building characteristics data.			
Impact	Data Cleaning					Monitored data from whole HVAC systems will be analyzed and prepared for the engineering analysis.			
Impact	Engineering Estimates					Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models representing a range of building ages and operating modes.			
Impact	Building Simulation Modeling					The calibrated DOE-2 simulation models will be run using long term average weather data for Charlotte, NC			
Impact	Billing Analysis							A statistical billing analysis of program participants will be conducted and compared to the engineering estimates.	
Impact	Impact Evaluation Report							Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	9/1/2012							

* Equipment installed, and enough participation for statistically significant results

Residential Smart $aver: Additional Measures

The process evaluation will include program manager and implementer interviews to assess program operations, participant surveys to assess program awareness, satisfaction, equipment replacement, and end-use persistence. The impact evaluation will include a billing analysis, and an engineering walk through, short term monitoring, building simulation modeling as appropriate.

EM&V for SC Proposed Residential Smart $aver: Additional Measures

Expected Start Date*: 3/1/2012

This program is pending approval, therefore the expected start date is tentative.

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
	Participant Surveys		Instrument Development	Conduct Surveys	Analysis				
	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis				
	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis				
	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Selective monitoring					Pre/post monitoring of whole HVAC systems. These data will be used to inform the DOE-2 simulation models			
	Site visits					Duke staff will conduct site visits at a sample of sites to verify unit installation and gather building characteristics data.			
	Data Cleaning						Monitored data from whole HVAC systems will be analyzed and prepared for the engineering analysis.		
	Engineering Estimates						Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models representing a range of building ages and operating modes.		
	Building Simulation Modeling						The calibrated DOE-2 simulation models will be run using long term average weather data for Charlotte, NC		
	Billing Analysis							A statistical billing analysis of program participants will be conducted and compared to the engineering estimates	
	Impact Evaluation Report							Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts								

* Equipment installed, and enough participation for statistically significant results

Residential Smart $aver: CFLs

The process evaluation includes program manager and implementer interviews to assess program operations, and participant and nonparticipant surveys to assess program awareness, satisfaction, and use/storage of CFLs. The impact evaluation will consist of an engineering analysis.

EM&V for SC Residential Smart $aver: CFLs

Expected Start Date*: 6/29/2011

	Months After Program Implementation-->	4	6	8	10	12	14
Process	Interview Program Managers and Implementers	Instrument Development		Conduct Interviews	Analysis		
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis		
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis		
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis		
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14
Impact	Engineering Estimates				Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.		
Impact	Impact Evaluation Report					Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	5/1/2011					

* Equipment installed, and enough participation for statistically significant results

Residential Smart $aver: Property Manager CFLs

The process evaluation includes program manager, implementer interviews to assess program operations, and property manager and occupant surveys to assess program awareness, satisfaction, and use/storage of CFLs. The impact evaluation will consist of an engineering analysis.

EM&V for SC Residential Smart $aver: Property Manager CFLs
Expected Start Date*:
8/31/2011

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
Process	Participant Surveys	Instrument Development		Conduct Surveys	Analysis			
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis			
Process	Interview Program Vendors (property managers)		Instrument Development	Conduct Surveys	Analysis			
Process	Process Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Engineering Estimates				Logger Study and Program Manager tracking data collection	Engineering estimates of savings will be developed for efficiency actions identified through the participant surveys. Average savings per participant based on self-reported efficiency actions will be calculated.		
Impact	Impact Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts							

* Equipment installed, and enough participation for statistically significant results

Smart $aver for Non-Residential Customers - Prescriptive Lighting

The process evaluation includes program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, satisfaction, equipment replacement, and end-use persistence. The impact evaluation includes short term monitoring and engineering estimations.

EM&V for SC Non-Residential Smart $aver Prescriptive Lighting
Expected Start Date*: 6/29/2011

	Months After Program Implementation-->	4	6	8	10	12	14
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis			
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis		
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis		
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis		
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14
Impact	Selective monitoring (may not be performed if valid data collected through Process Eval).			Pre/post monitoring of whole HVAC systems (need HVAC and VFDs). These data will be used to inform the DOE-2 simulation models			
Impact	Data Cleaning			Data from process evaluations and On site will be analyzed and prepared for the engineering analysis.			
Impact	Engineering Estimates			WECC database review	Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models.		
Impact	Impact Evaluation Report					Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	6/1/2011					

* Equipment installed, and enough participation for statistically significant results

Smart $aver for Non-Residential Customers - Prescriptive VFDs

The process evaluation includes program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, satisfaction, equipment replacement, and end-use persistence. The impact evaluation includes short term monitoring and engineering estimations.

EM&V for SC Non-Residential Smart $aver Prescriptive VFDs

Expected Start Date*
5/29/2012

	Months After Program Implementation-->	4	6	8	10	12	14	16
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis				
	Participant Surveys		Instrument Development	Conduct Surveys	Analysis			
	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis			
	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis			
	Process Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Months After Program Implementation-->	4	6	8	10	12	14	16
Impact	Selective monitoring (may not be performed if valid data collected through Process Eval).			Pre/post monitoring of whole HVAC systems (need HVAC and VFDs). These data will be used to inform the DOE-2 simulation models				
	Data Cleaning			Data from process evaluations and On site will be analyzed and prepared for the engineering analysis.				
	Engineering Estimates			WECC database review	Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models			
	Impact Evaluation Report						Final Report	Duke reviews and addresses report recommendations
	Effective Date of Impacts	1/1/2013						

* Equipment installed, and enough participation for statistically significant results

Smart $aver for Non-Residential Customers - Custom

The process evaluation includes program manager and implementer interviews to assess program operations, and participant surveys to assess program awareness, satisfaction, and equipment replacement, and end-use persistence. The impact evaluation will include selective, short term monitoring and building simulation modeling as appropriate.[11]

EM&V for SC Non-Residential Smart $aver Custom

Expected Start Date*
10/29/2011

	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Process	Interview Program Managers and Implementers	Instrument Development	Conduct Interviews	Analysis					
Process	Participant Surveys		Instrument Development	Conduct Surveys	Analysis				
Process	Non-Participant Surveys (as needed)		Instrument Development	Conduct Surveys	Analysis				
Process	Interview Program Vendors		Instrument Development	Conduct Surveys	Analysis				
Process	Process Evaluation Report					Final Report	Duke reviews and addresses report recommendations		
	Months After Program Implementation-->	4	6	8	10	12	14	16	18
Impact	Selective monitoring (may not be performed if valid data collected through Process Eval)			Pre/post monitoring of whole HVAC systems. These data will be used to inform the DOE-2 simulation models					
Impact	Data Cleaning			Data from process evaluations and On site will be analyzed and prepared for the engineering analysis					
Impact	Engineering Estimates					Building characteristics data from the verification surveys, and the data from the monitoring sample will be used to develop and calibrate a series of prototypical DOE-2 models			
Impact	Impact Evaluation Report							Final Report	Duke reviews and addresses report recommendations
Impact	**Effective Date of Impacts**	2/1/2012							

* Equipment installed, and enough participation for statistically significant results

[11] This schedule has been modified since the March 2011 summary. Extending the data collection and analysis period allows the team to get a more complete sample of participants in the last year of program operation. The 2012 sample frame will include as many 2012 sites as is practical (while allowing enough time for the M&V to complete in time for the final report). Also, samples drawn to date specifically excluded Smart Building Advantage participants, as these sites were planned to be analyzed separately. The 2012 sample will include SBA participants in the sample frame.

	First EM&V				Subsequent EM&V				
	Sample Date Ranges				Sample Date Ranges (Estimated)				
Program	Data for EM&V Analysis Paricipation Sample Start Date *	Data for EM&V Analysis Sample End Date	Date of First EMV Final Report	Actual Start Date of First EMV Impacts	Data for Next EM&V Analysis Participation Sample Start Date*	Data for Next EM&V Analysis Sample End Date	Expected Next Final Process Report	Expected Next Final Impact Report	Next EMV Expected Effective Dates
Residential SmartSaver CFL	9/1/2009	6/1/2010	4/26/2011	SAW Start	9/30/2010	4/30/2011	6/29/2012	6/29/2012	5/1/2011
Non-Residential Prescriptive (Lighting)	6/1/2009	4/30/2010	6/16/2011	SAW Start	5/1/2010	5/5/2011	6/29/2012	6/29/2012	6/1/2011
Non-Residential Prescriptive (VFDs)	6/1/2009	5/5/2011	2/2/2012	SAW Start	5/6/2011	12/31/2012	7/29/2013	7/29/2013	1/1/2013
Home Energy House Call (HEHC)	6/9/2009	7/31/2010	6/13/2011	SAW Start	8/1/2010	5/31/2012	11/1/2012	12/31/2012	6/1/2012
Residential Energy Assessments: Personalized Energy Report (PER)	10/28/2009	3/31/2011	11/15/2011	SAW Start	4/1/2011	6/30/2012	11/1/2012	1/1/2013	7/1/2012
Residential Energy Assessments: Personalized Energy Report (OHEC)	9/8/2009	3/31/2011	11/15/2011	SAW Start	4/1/2011	6/30/2012	11/1/2012	1/1/2013	7/1/2012
Energy Efficiency Education Program for Schools	10/17/2009	3/31/2011	11/17/2011	SAW Start	11/1/2011	8/31/2012	11/1/2012	3/1/2013	9/1/2012
Residential Smart Saver AC and HP	6/1/2009	6/30/2011	1/27/2012	SAW Start	7/1/2011	2/29/2012	7/1/2012	11/1/2012	3/1/2012
Low Income Energy Efficiency and Weatherization Assistance	(1)	(2)	(2)	Participation Start					
NonResidential Energy Assessments	(1)	Q4 2011	10/24/2011	(5)					
NonResidential Custom Incentives	9/1/2009	Q4 2012	Q4 2012	(6)					
Smart Energy Now (3)	10/28/2011	12/31/2012	Q1 2013	10/28/2011					
Home Energy Comparrison Report	5/1/2020	6/1/2011	11/8/2011	5/1/2010	5/1/2012	5/31/2013	5/1/2013	9/1/2013	6/1/2013

(1) Sample start date is a function of the timing of customer participation. The sample will be pulled using start date ranges that ensure a statistically significant analysis.

(2) Program was not administered as originally filed, thus participation delayed due to ARRA funds. Time frames depend on modified program launch date.

(3)Table assumes significant implementation during November 2011 thru July 2012
(4) Process and Impact evaluations sample frames may not coincide.
(5) NonResidential Energy Assessment Impacts will be included future NonResidential Smart$aver Evaluations.

(6) Not Applicable per EMV Settlement Agreement. Evaluation will be applied Q1 2013

TECMARKET Works

TecMarket Business Center
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Memorandum

To: Ashlie Ossege, Duke Energy
From: Nick Hall, TecMarket Works
Date: July 11, 2011
Subject: Low Income Programs and Freeridership

Typically low income evaluation studies indicate zero to very low freeridership levels for CFLs.

Studies have found that low-income households do not typically purchase CFLs but tend to acquire the ones they have via utility programs, social programs, low-income support efforts, and promotional giveaways. The price of a CFL is still substantially higher than standard bulbs and represents a cost barrier for low income populations. As a result, the NTG ratio used for low-income programs is typically around 1.0, suggesting few freeriders associated with energy program acquired CFLs.

This net-to-gross ratio of 1.0 has been applied to other low income evaluations, including the following.

- NYSERDA's evaluation of the Weatherization Network Initiative uses zero freeriders as the NTG adjustment factor.
- NYSERDA's Direct Installation Program for low income customer uses zero freerider as the NTG adjustment factor.
    - These values can be found in Table 7-2 on page 7-4:

      NYSERDA Low
      Income Section 7.pdf

- Arizona's SRP Low Income Weatherization evaluation reports zero freeriders for the utilities weatherization program. Cadmus, Energy Efficiency Portfolio Evaluation Summary, August 2010, for SRP
    - This value can be found in Table 1 on page 11:

      Arizona - Low
      Income Weatherizatic

Final Report

Evaluation of the 2009-2010 Residential Smart $aver® HVAC Program in North and South Carolina

Results of an Impact Evaluation

Prepared for
Duke Energy
139 East Fourth Street
Cincinnati, OH 45201

January 27, 2012

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Table of Contents

Executive Summary

Key Findings and Recommendations

An overview of the key findings identified through this evaluation is presented in this section.

Significant Impact Evaluation Findings

Table 1 presents the gross unit kWh and kW savings per ton associated with the Residential Smart $aver program. These results are obtained based on a model which uses the results of the engineering analysis within a statistical billing data analysis (the SAE approach).

Table 1. Energy Savings Per Ton Associated with the Residential Smart $aver Program in the Carolinas

Asheville NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	222	0.110	-5
AC_seer15	270	0.120	-6
AC_seer16	285	0.090	-6
AC_seer17	305	0.120	-6
Hp_seer14	399	0.100	0
Hp_seer15	372	0.130	0
Hp_seer16	422	0.167	0
Hp_seer17	245	0.170	0
Hp_seer18	447	0.180	0

Charlotte NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	244	0.150	-4
AC_seer15	301	0.140	-4
AC_seer16	335	0.110	-5
AC_seer17	366	0.140	-5
Hp_seer14	343	0.170	0
Hp_seer15	361	0.160	0
Hp_seer16	427	0.190	0
Hp_seer17	314	0.200	0
Hp_seer18	442	0.200	0

Greenville SC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	238	0.110	-4
AC_seer15	290	0.120	-4
AC_seer16	319	0.110	-6
AC_seer17	345	0.140	-6
Hp_seer14	367	0.100	0
Hp_seer15	366	0.140	0
Hp_seer16	429	0.180	0
Hp_seer17	284	0.180	0
Hp_seer18	448	0.190	0

Program participation by HVAC system type, size, SEER, and location were applied to the savings per ton estimates from Table 1 above to compute the program savings, as shown in Table 2.

Table 2. Summary of Program Savings by Measure

Measure	Participation Count	Gross Ex Post kWh Savings	Gross Ex Post kW Savings	Gross Ex Post kWh Savings per unit	Gross Ex Post kW Savings per unit
Air conditioner	6,086	5,053,612	2,149	830	0.353
Heat Pump	13,256	13,220,103	5,821	997	0.439

- The electronically commutated (EC) motors required by the program caused very little change in occupant behavior relative to supply fan usage. Large increases in supply fan operating hours after system installation were not observed. The proportion of fan systems operating continuously decreased slightly after system installation.
- The EC motors provided substantial savings in fan power consumption, on the order of 46%.
- Future evaluation monitoring should also include sites from North and South Carolina if monitoring resources can be provided to this effort. The monitoring should capture fan, compressor and strip heat energy to provide full unit heating and cooling data for model development and calibration.
- Engineering modeling revealed energy and demand savings that are not proportional to the difference in SEER. The SEER, which is based on a standardized laboratory test, is not a reliable predictor of annual energy consumption under the more realistic operating conditions included in the building energy simulation models. Higher SEER air conditioners and heat pumps typically rely on multiple compressors to improve part-load

performance, but may not provide proportional improvements in full-load efficiency. The results seen in this evaluation are consistent with results in other states.

- The billing analysis indicates that the participants realized 67% and 56% of the savings estimated by the engineering analysis for air conditioners and heat pumps, respectively. The air conditioner results are consistent with results for the Smart $aver program in other Duke Energy jurisdictions. Heat pumps system monitoring, as described above, is recommended to improve the engineering estimates of heat pump savings in the Carolinas.
- Participating dealers should record the make and model number of the replaced air conditioner and provide an assessment of the condition of the unit as part of the rebate application process. These data will allow the evaluation team to improve the estimate of the early replacement baseline efficiency.

Recommendation

- Duke Energy may wish to consider conducting an economic impact evaluation of key Duke Energy programs, including the Smart $aver Program, as previous studies suggest that job related impacts of energy efficiency programs may be substantial. Previous studies conducted on the economic impacts associated with energy efficiency programs show impacts in four job creation categories. These include: 1) Jobs created by helping businesses become more profitable by lowering their cost of operations, making them more competitive; 2) Lowering the energy cost of living for customers that increases their disposable income, which in turn supports jobs driven by expenditures other than energy; 3) Dollars spent more locally on non-energy expenditures keeps more dollars in the state being re-spent through the local economy creating more in-state jobs; and 4) Greater spending within non-energy economic streams leads to increased manufacturing, distribution and sales that require additional jobs to support consumer demand. Evaluations that assess economic effects of programs allow policy makers to understand a fuller range of program impacts. These evaluations can be conducted using secondary data (research conducted by others and applied to the Duke Energy programs) or use primary research depending on the reliability needs associated with the study findings.

Description of Program

The Duke Energy Residential Smart $aver program provides rebates for installations of higher efficiency heating and cooling measures in new or existing homes. Qualified purchases by residential customers are eligible for rebates of $200 to the homeowner, and $100 to the HVAC contractor/dealer. Home builders who install qualified equipment are eligible for rebates of $300 that they may choose to pass on to the home buyers.

There are two types of measures for which rebates are available: central air conditioners (CAC) with electronically commutated fan motors (ECM)s, and heat pumps with ECMs. Duke Energy provides rebates for measures that have higher efficiency performance levels that are above current federal standards.

To participate, Duke Energy customers work directly with a participating HVAC contractor, select the eligible equipment, and provide their Duke Energy account number. The contractor completes the application for the rebate, providing the necessary AHRI certificates. Duke Energy has contracted with a third party, program administrator (Wisconsin Energy Conservation Corporation, WECC) who then processes the rebates and sends incentives to the customer and/or the contractor.

The program has been highly successful, to the extent that halfway through the 2009 program year, the implementer (Wisconsin Energy Conservation Corp - WECC) was directed by Duke Energy to focus more attention on recruiting Non-Residential Smart $aver® trade allies in order to promote the non-residential program's services, and place less focus on the residential program. That is, program demand out-stripped the program's budget's ability to meet customer demand for the program. The limits on the approved budget and the associated cost recovery mechanism acted to moderate the program enrollment efforts limiting participation and energy savings.

Program Participation

The evaluation covers participants in the program spanning 2009 through 2010, with post customer data through June 2011. Engineering estimates were prepared for each program participant. The billing analysis included a near census of participants, as shown below:

Program	Impact Type	Participation Count for 2009-2010
Residential Smart Saver – Carolinas	Engineering	19,342
Residential Smart Saver – Carolinas	Billing	18,259

Methodology

The impact evaluation used an engineering approach combined with a statistical billing analysis in a Statistically Adjusted Engineering (SAE) model framework. The engineering-based approach to estimating program savings consisted of the following steps:

1. Analysis of contractor surveys
2. Analysis of program participation tracking system data
3. Development and calibration of prototypical building energy simulation models
4. Simulation of measure energy savings
5. True-up of engineering estimates with billing data using a Statistically Adjusted Engineering (SAE) approach
6. Calculation of gross program energy and demand savings

The engineering estimates were then combined with a billing analysis comparing the pre and post program energy consumption levels to the engineering estimates of savings for each participant.

This approach differs from most of the other evaluations of similar programs in that it combines both an engineering and a billing analysis. Other evaluations have either used one or the other. Those evaluations that use only engineering analysis (even if they calibrated using billing data), ignore changes in customer HVAC usage associated with the installation of higher efficiency units and other behavior changes.[1] Evaluations that depend only upon a billing analysis can only capture the early replacement of equipment – they cannot capture the natural replacement savings (i.e., the baseline is not the actual efficiency of the existing HVAC system, but the current HVAC efficiency standards).

The Residential Smart $aver HVAC program is designed as a time of replacement program. Incentives are offered to encourage customers to upgrade from a standard efficiency new air conditioner or heat pump to a higher efficiency new system when the existing system is at the end of its service life. This is commonly referred to a "normal replacement" scenario. The baseline efficiency assumed for the program is a SEER 13 minimally code-compliant air conditioner or heat pump. In some cases, the customer may be encouraged by the program to replace their existing air conditioner or heat pump before the existing system is at the end of its service life. This is commonly referred to as an "early replacement" scenario. Under an early replacement scenario, the existing HVAC system is the baseline, and the life cycle savings accrue using the existing system baseline for the remaining useful life of the existing system. Once the existing system reaches the end of its service life, the baseline reverts to the normal replacement baseline, and the life cycle savings accrue until the end of the service life of the new equipment. This is commonly referred to as the "dual baseline" approach, which is shown in the equation below:

$$\text{Life cycle kWh savings} = (kWh_{ER} - kWh_{EE}) \times RUL + (kWh_{NR} - kWh_{EE}) \times (EUL - RUL)$$

[1] For example, the 2009 EM&V Report for the Home Energy Improvement Program for Progress Energy.

where:

kWh_{ER} = kWh consumption of the existing system
kWh_{EE} = kWh consumption of the efficient (rebated) system
kWh_{NR} = kWh consumption of a minimally code compliant system
RUL = remaining useful life of the existing system
EUL = effective useful life of the efficient (rebated) system

Under the normal replacement scenario, the savings are simply:

$$\text{Life cycle kWh savings} = (kWh_{NR} - kWh_{EE}) \times EUL$$

As discussed above, it is reasonable for the program to claim the savings associated with early replacement, these savings can only be claimed for the remaining life of the replaced unit, after which the claimed savings revert to the normal replacement level. However, it is extremely difficult and expensive to derive accurate estimates of the replaced unit's remaining life, so this evaluation takes the conservative approach, where all replacements were considered to be normal replacements.

To convert the early replacement savings estimate obtained from the billing analysis, the estimated realization rate (using engineering estimates with a 10 SEER early replacement baseline), was multiplied by the engineering-based loss in savings associated with going from a 10 SEER to a 13 SEER (the normal replacement baseline). This represents approximately a 70% reduction in savings.

Finally, during the initial phase of this evaluation, it was discovered that there was a marked difference between the engineering analysis and billing analysis in the preliminary results. This difference was a result of using different participant samples for the engineering and billing analyses. (Please see Appendix C: November 23, 2011 Memo to Duke Energy for more information.) This disparity warranted further investigation and analysis, which resulted in the same participation group used for both the billing and the engineering analysis, the final results of which are presented in this report.

Data collection methods, sample sizes, and sampling methodology

Engineering Estimates

Smart $aver program participation records for all participants covering the period through December, 2010 were obtained from Duke Energy.

Billing Analysis

The results from the billing analysis represent the entire population of participants with usable billing data, so no sample design was necessary.

Number of completes and sample disposition for each data collection effort

Engineering Estimates

Smart $aver program participation records for all participants covering the period through December, 2010 were obtained from Duke Energy.

Billing Analysis

Program tracking data was used to pull billing data from all participants in North and South Carolina. The billing data was combined with information on participation date and in turn linked to weather data (temperature) to form the dataset used in the regression analysis.

Expected and achieved precision

Engineering Estimates

Not applicable. Census of participants used in the study.

Billing Analysis

All savings estimates from the billing analysis were statistically significant at the 95% confidence level.

Description of baseline assumptions, methods and data sources

Engineering Estimates

Baseline assumptions are incorporated into the prototypical simulation models derived from the residential building prototypes used in the California Database for Energy Efficiency Resources (DEER) study, with adjustments made for local building practices and climate. A detailed description can be seen in Table 3.

Description of measures and selection of methods by measure(s) or market(s)

Engineering Estimates

DOE-2.2 simulations were used to estimate savings from all measures, air conditioners and heat pumps ranging from SEER 14 to SEER 18.

Billing Analysis

The billing analysis was used to true up the engineering estimates. The realization rate from the SAE model was used to adjust the engineering estimates of savings for air conditioners and heat pumps ranging from SEER 14 to SEER 18.

Threats to validity, sources of bias and how those were addressed

Engineering Estimates

Any potential for bias in the engineering estimates is minimized through the use of building energy simulation models, which are considered to be state of the art for building shell and HVAC system analysis. Seasonality in heating and cooling energy use, and the use of natural ventilation during mild weather in the cooling season is incorporated to reduce upward bias in the engineering estimates. The engineering models are informed by pre/post metered data on fan usage at a sample of sites, and trued up to the billing analysis described below.

Billing Analysis

The specification of the model used in the billing analysis was designed specifically to avoid the potential of omitted variable bias by including monthly variables that capture any non-program effects that affect energy usage. The model did not correct for self-selection bias because there is no reason to as long as the program remains voluntary.

Snapback and Persistence

The theoretical additional energy and capacity used by customers that may occur from implementing an energy efficiency product, often called "snapback" if it occurs, is by design already captured in the impact evaluation through the billing analysis approach. The billing analysis approach uses actual energy use between the pre and post condition compared to what would occur without the program (control). All market or program effects conditions, including snapback, are already accounted for in this evaluation method. This is contrasted to evaluations that primarily rely upon engineering calculations.

The billing data analysis, by using usage data from customers who participated as long as over two years ago, indicates that the impacts of the Smart $aver program are likely to persist for at least two years. However, the evaluation did not address how long these savings are likely to persist over time because the time span of the available data was not sufficient to address this issue. Both persistence and technical degradation are included in the calculation of each measure's effective useful life shown in Appendix B: DSMore Table.

Energy Impact Analysis and Findings

Program Tracking System Analysis

Smart $aver program participation records covering the period through December 2010 were obtained from Duke Energy. The data, delivered as an Excel spreadsheet, contained customer name and address, installing vendor contact information, system type and efficiency, unit make and model number, rebate amounts, and other information. These data were examined to identify the number and types of customers and HVAC systems in the program.

The distribution of equipment type listed in the program tracking database is shown in Figure 1.

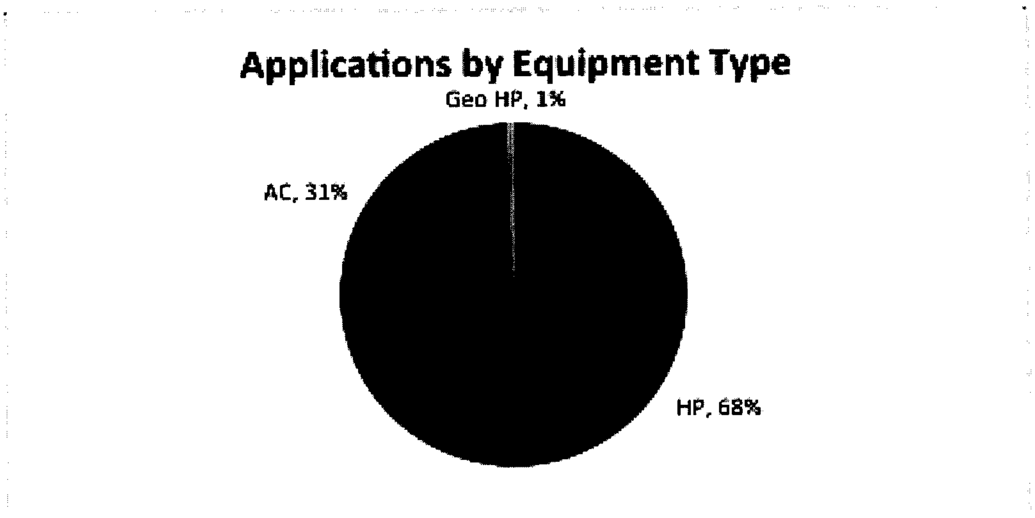

Figure 1. Applications by Equipment Type

Heat pumps make up about two thirds of the applications listed in the program tracking database received from Duke Energy. Air conditioners make up about one third of the applications. A negligible number of geothermal heat pump applications were recorded.

The frequency of rebated units and their efficiency is shown below.

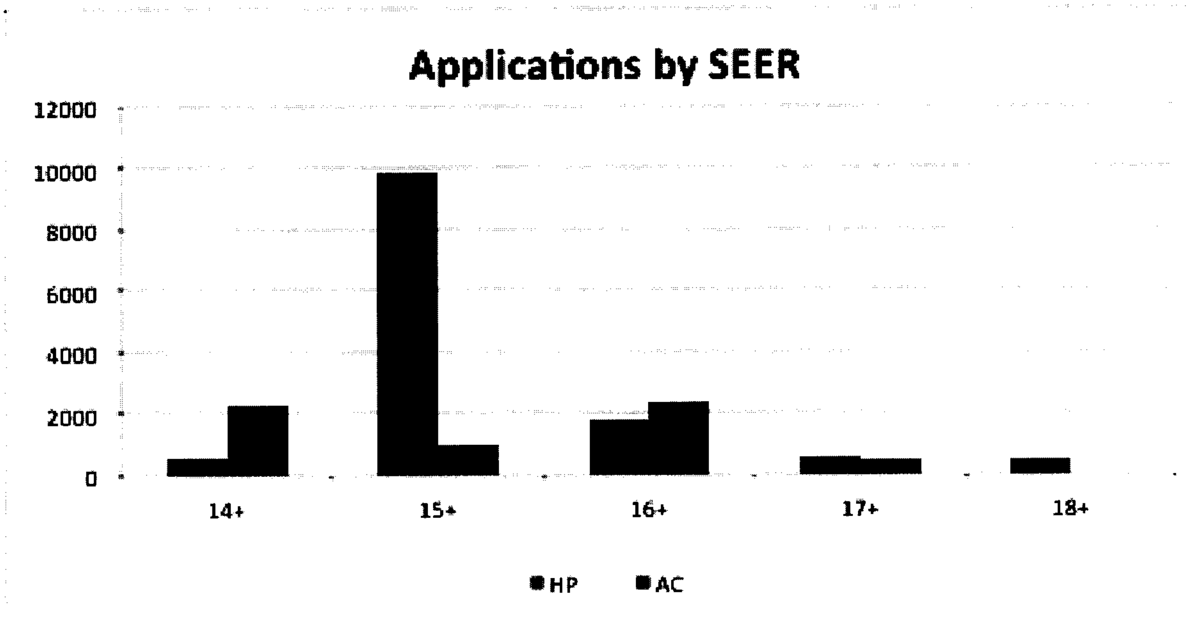

Figure 2. Heat Pump and Air Conditioner Applications by SEER

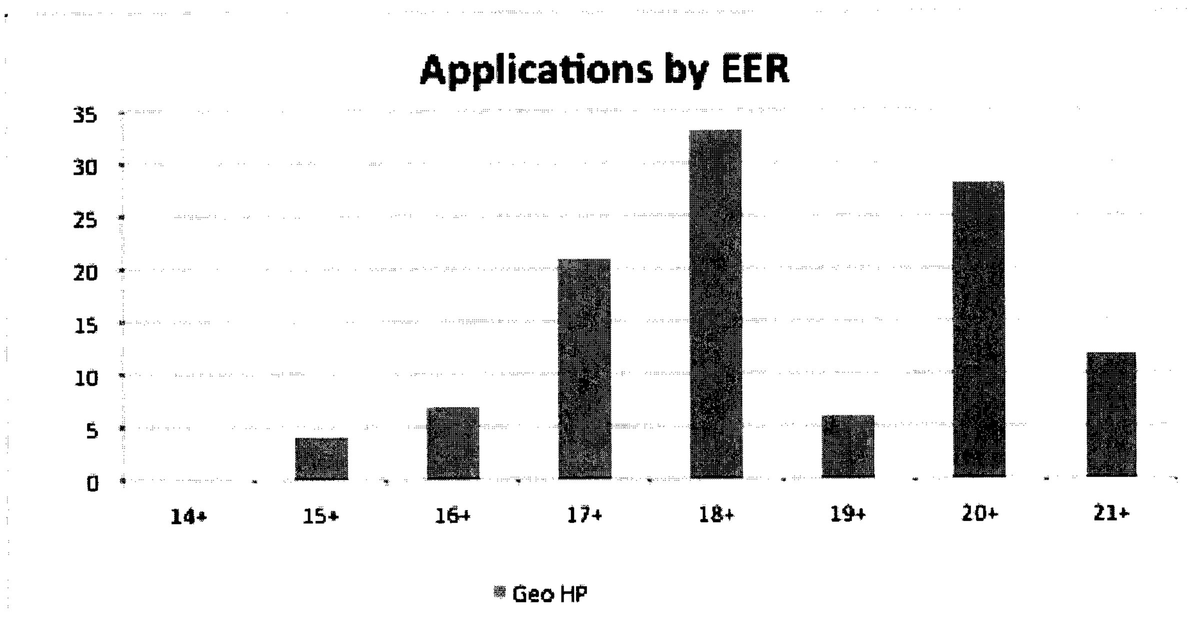

Figure 3. Geothermal Heat Pump Applications by EER

Engineering-Based Analysis

The impact analysis for the Residential Smart $aver program is based on a combination of engineering estimates and billing data analysis. The engineering estimates are based on DOE-

2.2 simulations of a set of prototypical residential buildings. The prototypical simulation models were derived from the residential building prototypes used in the California Database for Energy Efficiency Resources (DEER) study, with adjustments made for local building practices and climate. The prototype "model" in fact contains 4 separate residential buildings; 2 one-story and 2 two-story buildings. Each version of the 1 story and 2 story buildings are identical except for the orientation, which is shifted by 90 degrees. The selection of these 4 buildings is designed to give a reasonable average response of buildings of different design and orientation to the impact of energy efficiency measures. A sketch of the residential prototype buildings is shown in Figure 4.

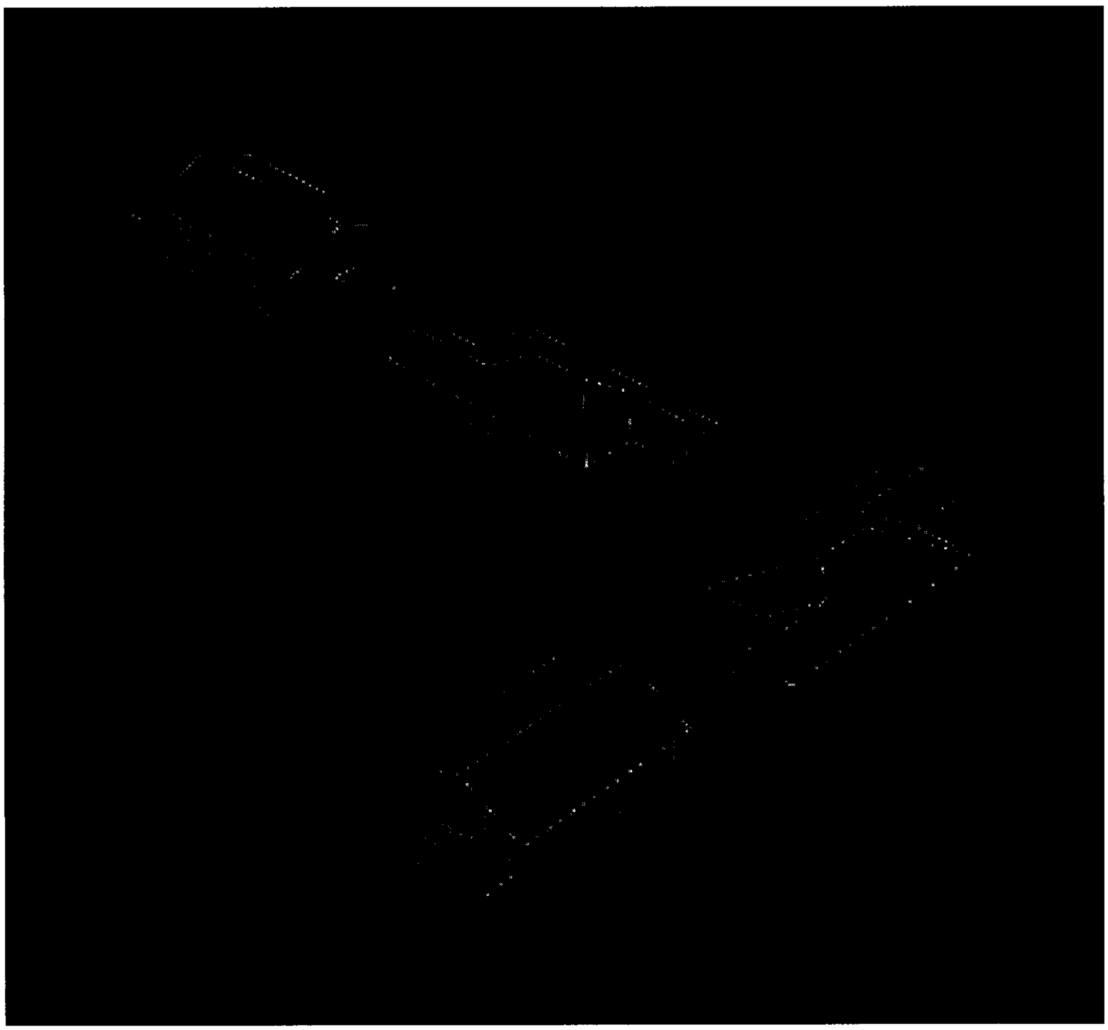

Figure 4. Computer Rendering of Residential Building Prototype Model

The general characteristics of the residential building prototype model are summarized in Table 3.

Table 3. Residential Building Prototype Description

Characteristic	Value
Vintage	Three vintages simulated: 1959 and older, 1960 – 1989, and 1990 and newer
Conditioned floor area	1 story house: 1465 SF (not including basement) 2 story house: 2930 SF (not including basement)
Wall construction and R-value	Wood frame with siding, R-value varies by system type and vintage
Roof construction and R-value	Wood frame with asphalt shingles, R-value varies by system type and vintage
Glazing type	Average of single and double pane; properties vary by system type and vintage
Lighting and appliance power density	0.51 W/SF average
HVAC system type	Packaged single zone AC or heat pump
HVAC system size	Based on peak load with 20% oversizing.
HVAC system efficiency	Baseline SEER = 13 for normal replacement; SEER = 10 for early replacement Furnace efficiency = 0.78 AFUE
Thermostat setpoints	Heating setpoint = 70, cooling setpoint =75. Night setback/setup of 5 degrees in runs with setback thermostats.
Duct location	Unconditioned attic
Duct surface area	Single story house: 390 SF supply, 72 SF return Two story house: 505 SF supply, 290 SF return
Duct insulation	Uninsulated
Duct leakage	20% total, evenly distributed between supply and return
Cooling season	Asheville: March 25 – September 20 Charlotte: March 17 – October 6 Greenville: March 23 – October 7
Natural ventilation	Allowed during cooling season when cooling setpoint exceeded and outdoor temperature < 65°F. 3 air changes per hour

Several of the building characteristics were varied by vintage and HVAC system type to reflect the differences noted in the appliance saturation survey. These characteristics are described below.

Wall, Floor and Ceiling Insulation Levels

The assumed values for wall, floor, and ceiling insulation and the assumed average R-value by vintage is shown in Table 4.

Table 4. Insulation R-Value Assumptions by Vintage

Vintage	R-value of wall	R-value of ceiling
1959 and older	4.8	11
1960 - 1989	11	19
1990 and newer	13	38 (Asheville) 30 (Charlotte and Greenville)

Windows

The glazing property assumptions are shown in Table 5.

Table 5. Glazing Property Assumptions by Vintage

Vintage	U-value	SHGC
1959 and older	1.27	0.88
1960 - 1989	0.87	0.77
1990 and newer	0.40 (Asheville) 0.65 (Charlotte and Greenville)	0.55 (Asheville) 0.40 (Charlotte and Greenville)

Model Calibration

The DOE-2 models were refined using monitored data supplied by Duke Energy on residential central air conditioners and heat pumps in Ohio and Indiana. Very little data currently exist on the use of residential central air conditioners and heat pumps with ECMs. This issue has been studied in Wisconsin and by Duke Energy in Ohio and Indiana. This evaluation uses the Ohio and Indiana data because it was the best available information on this topic. Dent Elite Pro true electric power meters were installed on the furnace/air handler fans at a sample of sites. Time series measurements of fan power before and after the Residential Smart $aver system installations were made. The dataloggers were rotated from site to site, with some systems monitored during the heating season while other systems were monitored during the cooling season. Note, only the fan power was monitored; total unit power was not included in the monitoring activity. The purpose of the monitoring was to assess the fan power differences resulting from including an electronically-commutated (EC) motor as a program requirement. EC motors are much more efficient than standard motors, improving the SEER rating of an air conditioner or heat pump. The EC motor also allows for fan speed modulation, saving additional fan energy during part-load operation. Homeowners may elect to run their systems with continuous low speed fan operation regardless of heating or cooling needs to improve comfort and indoor air quality. Under this type of control, the energy savings from EC motor installation are reduced due to longer operating hours.

The monitored data were analyzed to determine the fan operation (continuous vs. cycling with call for heat/cool) and fan power per ton of cooling capacity in the pre and post installation case. The result of the monitored data analysis is shown in Table 6.

Table 6. Summary of Furnace Fan Motor Monitoring

Unit Monitored	Cycling Fan Fraction	Continuous Fan Fraction	Average Fan Power at Full Flow (W/cfm)
Existing	42%	58%	0.367
New	51%	49%	0.197

The existing units were more likely to operate with a continuous fan (58% of existing units vs. 49% of replacement units). While continuous fan operation is a feature of systems with EC motors, about half of the systems monitored used the feature.

The average fan power at full flow for the existing units was 0.365 W/cfm, while the average fan power at full flow for the replacement units was 0.197 W/cfm, representing a savings of 46% in full load fan power. Additional fan savings due to reduced speed operation were analyzed using the DOE-2.2 simulation models described in the next section.

The prototype model was simulated with a variety of efficiency measures to develop a series of savings estimates. The engineering analysis provided two sets of estimates. Separate estimates were generated for both normal replacement (replace on failure) and early replacement scenarios. Under the normal replacement scenario, air conditioning systems were simulated with a baseline SEER 13 air conditioner and with a series of high efficiency air conditioners ranging from SEER 14 to SEER 17. Heat pump systems were simulated with a baseline SEER 13 heat pump and with a series of high efficiency heat pumps ranging from SEER 14 to SEER 18. Under the early replacement scenario, the baseline unit efficiency was set at SEER 10, which is typical of units manufactured 20 years ago. The analysis required two sets of estimates. The early replacement baseline was used to compare the engineering analysis to the billing analysis. This comparison yielded an engineering adjustment factor. The adjustment factor was then applied to the engineering estimates developed under the normal replacement scenario. The adjusted, normal replacement engineering estimates were used to develop the final results.

The basic efficiency assumptions for each of the air conditioner and heat pump measures are shown in Table 7. These data were taken from an extensive study of residential air conditioners and heat pumps conducted for the California DEER update study.[2] Besides these basic efficiency parameters, an extensive set of performance curves were developed representing mean performance of production units in each SEER category. These performance curves describe unit efficiency as a function of outdoor temperature, part-load efficiency, and so on. Fan power data were taken directly from the metering study. These curves were also applied to air conditioner and heat pump measures in each SEER category.

Table 7. Baseline and Measure Performance Assumptions

Type	Efficiency	Fan Type	EER	Sensible Heat Ratio	Air flow (CFM/ton)	Heating COP
Air conditioner	SEER 10	Std 1-speed	9.3	0.74	396	
	SEER 13	Std 1-speed	11.1	0.75	376	
	SEER 14	EC motor	13.2	0.71	361	
	SEER 15	EC motor	12.7	0.7	320	
	SEER 16	EC motor	11.6	0.81	409	
	SEER 17	EC motor	12.3	0.8	422	
Heat pump	SEER 10	Std 1-speed	9.0	0.69	371	3.0
	SEER 13	Std 1-speed	11.1	0.73	337	3.28
	SEER 14	EC motor	12.2	0.73	352	3.52
	SEER 15	EC motor	12.7	0.81	436	3.74
	SEER 16	EC motor	12.1	0.78	400	3.48
	SEER 17	EC motor	12.5	0.81	430	3.26
	SEER 18	EC motor	13.0	0.78	404	3.18

[2] Itron, 2005. "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report," Itron, Inc., J.J. Hirsch and Associates, Synergy Consulting, and Quantum Consulting. December, 2005. Available at http://eega.cpuc.ca.gov/deer

This set of measures resulted in a simulation run matrix as follows:

Category	Number	Description
Building Vintage	3	1959 and older, 1960 – 1989, and 1990 and newer
HVAC systems	2	Air conditioner with gas furnace Standard heat pump with electric backup
Air conditioner efficiency levels	7	Base and 5 measures
Heat pump efficiency levels	8	Base and 6 measures
Furnace fan control	2	Continuous and intermittent
Tstat type	2	Setback and no setback

Evaluation Findings

The set of simulations described above were conducted for Asheville NC, Charlotte NC and Greenville SC. The results for each of the vintages were weighted according to the relative frequency of each vintage in the overall population. The simulated savings were normalized per ton of cooling capacity. A summary of the simulation results is shown in Table 8. Savings results are shown for each SEER class and air conditioner or heat pump type. Engineering estimates were provided using a normal replacement (SEER 13) baseline and an early replacement (SEER 10) baseline. The estimates for early replacement were prepared for consistency with the billing analysis, which observes the change in consumption as existing equipment is replaced with the efficient equipment.

Table 8. Normalized Measure Savings from Prototype Simulations for All Vintages[3]

Asheville

Measure	Normal Replacement			Early Replacement[4]	
	kWh/ton	kW/ton	Therm/ton	kWh/ton	kW/ton
AC_seer14	279	0.11	-6	722	0.401
AC_seer15	340	0.12	-7	782	0.406
AC_seer16	408	0.09	-8	851	0.383
AC_seer17	436	0.12	-9	879	0.406
Hp_seer14	550	0.10	0	918	0.268
Hp_seer15	512	0.13	0	881	0.302
Hp_seer16	820	0.41	0	1189	0.531
Hp_seer17	477	0.17	0	846	0.339
Hp_seer18	869	0.18	0	1237	0.343

Charlotte

[3] Normalized energy savings are a weighted average of the results for each of the building vintages.
[4] The billing analysis was conducted on electricity consumption data only. No gas interactions were evaluated.

Measure	Normal Replacement			Early Replacement[5]	
	kWh/ton	kW/ton	Therm/ton	kWh/ton	kW/ton
AC_seer14	307	0.15	-5	937	0.47
AC_seer15	379	0.14	-5	1009	0.46
AC_seer16	480	0.11	-7	1111	0.44
AC_seer17	524	0.14	-7	1155	0.46
Hp_seer14	472	0.17	0	875	0.35
Hp_seer15	497	0.16	0	900	0.33
Hp_seer16	830	0.19	0	1233	0.37
Hp_seer17	610	0.20	0	1014	0.38
Hp_seer18	859	0.20	0	1262	0.38

Greenville

Measure	Normal Replacement			Early Replacement[6]	
	kWh/ton	kW/ton	Therm/ton	kWh/ton	kW/ton
AC_seer14	299	0.11	-5	778	0.41
AC_seer15	365	0.12	-5	844	0.41
AC_seer16	457	0.11	-8	935	0.41
AC_seer17	493	0.14	-8	972	0.43
Hp_seer14	505	0.10	0	894	0.28
Hp_seer15	504	0.14	0	892	0.32
Hp_seer16	833	0.18	0	1222	0.37
Hp_seer17	551	0.18	0	940	0.36
Hp_seer18	870	0.19	0	1259	0.37

The engineering analysis used detailed performance maps for air conditioners and heat pumps at each SEER level. The detailed performance maps were derived from engineering data published by the unit manufacturers, and were compiled by the California Database for Energy Efficiency Resources (DEER) project. The most recent version of the DEER performance maps were used for this evaluation[7]. The performance maps addressed unit full load efficiency and capacity over a range of outdoor and indoor temperature and humidity conditions; and the effects of part-load operation on unit efficiency. The simulation models include the effect of duct leakage into return air systems on HVAC system performance, which in turn affects the temperature and humidity

[5] The billing analysis was conducted on electricity consumption data only. No gas interactions were evaluated.
[6] The billing analysis was conducted on electricity consumption data only. No gas interactions were evaluated.
[7] See www.deeresources.com for DEER documentation. The HVAC performance maps are described in the Summary of Energy Analysis Changes in 2008 DEER versus 2005 DEER document, which is accessed from the DEER 2008 for 09-11 Planning/Reporting section under the DEER Database Contents heading.

of the entering air conditions. The detailed simulation modeling formed the basis of the engineering estimates.

Note, the energy and peak demand savings derived from the simulations are not proportional to the difference in SEER. The SEER, which is based on a standardized laboratory test, is not a reliable predictor of annual energy consumption under the more realistic operating conditions included in the building energy simulation models. Peak demand savings across the SEER levels are due to different strategies used by manufacturers to achieve a particular SEER rating and the influence of those strategies on energy efficiency under peak conditions. For example, units using multiple compressors can have high SEER ratings, while having relatively poor efficiency under peak conditions. Heat pumps save energy for both heating and cooling, thus the overall annual energy savings are greater for heat pumps than air conditioners. Also, heat pumps have different performance characteristics than air conditioners, causing differences in the demand savings within each SEER class. Energy savings as a function of unit SEER are based on the performance of units under operating conditions representative of units in the Carolinas, especially when considering the influence of warm moist air infiltration into the return air systems on system performance.

The savings per ton from the table above were applied to each participant in the program tracking system according to the installed cooling capacity (tons), location and the SEER of the rebated unit to create a customer specific estimate of savings. The customer specific estimates using the early replacement baseline (i.e., SEER 10) were then passed to billing analysis, as described in the next section. The resulting realization rate was then modified by the difference in the engineering-based savings associated with going from the early replacement baseline to the normal replacement baseline.

Billing Analysis

This section of the report presents the results of a billing analysis conducted over the participants in the North and South Carolina Residential Smart $aver program. Billing data was obtained for all participants in the program between January, 2009 and March, 2011 and that had accounts with Duke Energy (after processing, there were a total of 15,046 accounts from North Carolina, and 3,213 were from South Carolina).[8] A panel model was used to determine program impacts, where the dependent variable was monthly electricity consumption from January 2009 to June 2011. Since engineering estimates were available for all these participants, a Statistically Adjusted Engineering (SAE) model was used for the analysis. The SAE model uses the customer-specific engineering savings estimate as the program variable, and the resulting estimated coefficient indicates the percentage of the engineering estimate realized on average by participants (i.e., the realization rate). The results of the billing analysis are presented in Table 9.[9]

Table 9. Estimated Carolina Residential Smart $aver Impacts: Billing Analysis

Program Component	Realization Rate	t-value
AC	67%	38.8
Heat Pump	56%	40.1

This table shows that the Residential Smart $aver program produced statistically significant savings for participants in the Carolinas. The realization rate indicates that the savings from this billing analysis is lower than the savings based upon the engineering analysis. This is often the case because the estimated realization rate captures several factors:

- Customer behavior. The engineering analysis assumes that there is no change in customer behavior with the installation of the new HVAC system. In practice, the addition of a new energy efficient system results in a decline in the cost of heating and cooling, so it is reasonable to assume that some customers will increase their heating/cooling.
- Actual home thermodynamics. The engineering analysis used a set of representative houses to develop the impact estimates. The billing analysis essentially captures the thermodynamics of specific to each house. Since some houses may vary significantly from the set of representative houses, their actual savings may therefore be significantly different as well.
- Status of pre-system. The billing analysis essentially compares the pre-installation usage to the post-installation usage. If some customer's pre-

[8] In order to maximize the use of the data, a single model was estimated over all states (Ohio, North Carolina, and South Carolina). Therefore, the actual sample size in the model also included 10,774 houses in Ohio, for a total sample size of 29,033 households.

[9] In order to insure an accurate separation between the pre and post participation periods, for each customer, the billing data for the period of time between the reported installation date (which may not accurately reflect when the new HVAC system installation was running) and the receipt of the rebate application was eliminated. In a vast majority of the cases this period was less than 2 months.

installation HVAC system was not functional, then the billing analysis will show an increase in electricity usage, and the overall estimated program savings will be lower than the case with functioning systems (which is the assumption in the engineering analysis).

- Actual baseline efficiency. The engineering analysis assumed that all customers had a fixed baseline efficiency. However, the billing analysis implicitly uses the actual efficiency of the customer's HVAC system, which may be higher or lower than the efficiency assumed in the engineering analysis.

The remainder of this section discusses the procedure used in the billing analysis.

For this analysis, data are available both across households (i.e., cross-sectional) and over time (i.e., time-series). With this type of data, known as "panel" data, it becomes possible to control, simultaneously, for differences across households as well as differences across periods in time through the use of a "fixed-effects" panel model specification. The fixed-effect refers to the model specification aspect that differences across homes that do not vary over the estimation period (such as square footage, heating system, etc.) can be explained, in large part, by customer-specific intercept terms that capture the net change in consumption due to the program, controlling for other factors that do change with time (e.g., the weather).

Because the consumption data in the panel model includes months before and after the installation of measures through the program, the period of program participation (or the participation window) may be defined specifically for each customer. This feature of the panel model allows for the pre-installation months of consumption to effectively act as controls for post-participation months. In addition, this model specification, unlike annual pre/post-participation models such as annual change models, does not require a full year of post-participation data. Effectively, the participant becomes their own control group, thus eliminating the need for a non-participant group.

The fixed effects model can be viewed as a type of differencing model in which all characteristics of the home, which (1) are independent of time and (2) determine the level of energy consumption, are captured within the customer-specific constant terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique household.

Algebraically, the fixed-effect panel data model is described as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it},$$

where:

y_{it} = energy consumption for home i during month t
α_I = constant term for site i
β = vector of coefficients
x = vector of variables that represent factors causing changes in energy consumption for home i during month t (i.e., weather and participation)

ε = error term for home i during month t.

With this specification, the only information necessary for estimation is those factors that vary month to month for each customer, and that will affect energy use, which effectively are weather conditions and program participation. Other non-measurable factors can be captured through the use of monthly indicator variables (e.g., to capture the effect of potentially seasonal energy loads).

The effect of the Residential Smart $aver program is captured by including a variable which is equal to zero for the months prior to participation, and the engineering estimate (on a monthly basis) for all months after the household participated in the program. The coefficient on this variable is the realization rate, and indicates the relationship between the engineering estimate and the billing data estimate (if the estimate is greater than one, the billing data indicates a higher savings than the engineering estimate. If the coefficient is less than one, then the billing data indicates a smaller savings than the engineering models). In order to account for differences in billing days, the usage was normalized by days in the billing cycle. The estimated model is presented in Table 10.[10]

Table 10. Estimated Savings Model – dependent variable is (daily kWh usage), January 2009 through June 2011 (savings are negative).

Independent Variable	Coefficient (percentage / 100)	t-value
Ohio – AC Eng. Est.	-0.55	-11.89
Ohio – HP Eng. Est.	-1.09	-69.24
Carolina – AC Eng. Est.	-0.67	-40.12
Carolina – HP Eng. Est.	-0.56	-38.80
Sample Size	725,874 observations (29,033 homes)	
R-Squared	73%	

The complete estimate model, showing the weather and time factors, is presented in Appendix A: Estimated Statistical Model.

The billing analysis represents a pre/post comparison of energy consumption, using the existing air conditioner or heat pump as the "pre" equipment.

The realization rate from the billing analysis (based upon the early replacement engineering estimates) was applied to the ratio of the savings associated with the early replacement to normal replacement engineering estimates, to give an estimate of the normal replacement energy savings. Since the billing analysis did not address demand savings, the engineering estimates of peak demand were not adjusted. The final billing analysis adjusted gross energy and demand savings per ton estimates are shown in Table 11.

Table 11. Adjusted Gross Energy and Demand Savings Per Ton

[10] As stated previously, a single model was estimated over participants in all states. Thus, this table presents the impacts for the Ohio in addition to the impacts for the Carolinas.

Asheville NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	222	0.110	-5
AC_seer15	270	0.120	-6
AC_seer16	285	0.090	-6
AC_seer17	305	0.120	-6
Hp_seer14	399	0.100	0
Hp_seer15	372	0.130	0
Hp_seer16	422	0.167	0
Hp_seer17	245	0.170	0
Hp_seer18	447	0.180	0

Charlotte NC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	244	0.150	-4
AC_seer15	301	0.140	-4
AC_seer16	335	0.110	-5
AC_seer17	366	0.140	-5
Hp_seer14	343	0.170	0
Hp_seer15	361	0.160	0
Hp_seer16	427	0.190	0
Hp_seer17	314	0.200	0
Hp_seer18	442	0.200	0

Greenville SC

Measure	Gross Energy and Demand Savings Per Ton		
	kWh/ton	kW/ton	Therm/ton
AC_seer14	238	0.110	-4
AC_seer15	290	0.120	-4
AC_seer16	319	0.110	-6
AC_seer17	345	0.140	-6
Hp_seer14	367	0.100	0
Hp_seer15	366	0.140	0

Hp_seer16	429	0.180	0
Hp_seer17	284	0.180	0
Hp_seer18	448	0.190	0

Program participation by HVAC system type, size, SEER, and location were applied to the savings per ton estimates from Table 11 above to compute the program savings, as shown in Table 12.

Table 12. Summary of Program Savings by Measure

Measure	Participation Count	Gross Ex Post kWh Savings	Gross Ex Post kW Savings	Gross Ex Post kWh Savings per unit	Gross Ex Post kW Savings per unit
Air conditioner	6,086	5,053,612	2,149	830	0.353
Heat Pump	13,256	13,220,103	5,821	997	0.439

The kW savings estimated for the program are summer peak demand savings at the customer meter. Estimates of utility coincident peak savings were not included in the study. Coincidence factors are applied to the customer peak savings in the DSMore cost effectiveness tool to estimate coincident peak savings.

Net-to-Gross Analysis for Impact Estimates

The evaluation examined the extent to which customers would have taken the same actions without the Duke Energy incentive and the degree to which the program participation impacted the adoption of additional energy efficient measures. This analysis used two different approaches. The first approach assessed the degree of the influence of the program and the program's rebate on the customer's decision to buy. This approach used self-reports of 50 surveyed program participants to estimate freeridership. The second analysis focused on the opinions of the dealers and trade allies providing a reduced price to the customers as a result of the Duke Energy rebate. This approach used in-depth interviews with participating dealers selling the program covered products (heat pumps and central air conditioning systems). In this analysis we contacted 32 participating dealers asking for them to complete an in-depth interview for the evaluation effort. We were successful at obtaining interviews from 8 of the participating dealers. These results are presented in the program process evaluation report finalized in 2011.

One of the findings from the process evaluation report is that the program is primarily promoted through the dealership networks rather than direct promotion to the customer. That is, when customers shop for an energy efficient program-covered appliance the dealer presents the customer with the price of the various models and levels of energy efficiency. The customer then makes a purchase decision based on the characteristics of the models available, the price of those products and their individual purchase preferences. This sales and marketing approach means that the customer makes their purchase decision based on the product characteristics and the dealer provided sales price without being able to fully understand the conditions impacting that price. In these types of purchase decisions, the customer is not aware of the influence of the Duke Energy rebate on the price of the package being presented to the customer. Because the price of the program-covered equipment is presented to the customer after the dealer has already deducted the Duke Energy incentive from their sales price, the customer is typically not aware that the price being quoted is a function of the application of the Duke Energy rebate. Under these conditions, the customers' self-reported impacts of the program's incentive are not able to be estimated by the customer making the purchase. As a result, TecMarket Works considers the results of the freerider assessment within the participant survey to be unreliable for the purposes of estimating net energy impacts. TecMarket Works does consider the results reliable for advising Duke Energy program managers about the opinions of their customers regarding the influence of the program on their purchase decision within the limited context of the information that they have (and do not have) regarding the influence of the program on the price they are paying.

These opinions are confirmed in the customer survey results in which the majority (82%) indicated that the Duke Energy price incentive had little effect on their purchase decision. Because dealers typically filled out the rebate form and acquired the rebate on behalf of the customer, the customer was typically unaware of the level of the Duke Energy incentive or its level of influence on the price of the acquired equipment. Of the completed 50 participating customer interviews, only 7 customers recall filling out the application form for the Duke Energy program rebate. The majority of participating customers are unable to credit the Duke Energy program as a cause of their purchase decision, even when the program impacted that decision by lowering their purchase price.

For the purposes of the impact evaluation and estimating net energy savings caused by the program, TecMarket Works relies only on the results of the dealer interviews. Of the eight dealers interviewed, five were able to provide what they considered to be reliable estimates of successful sales increases for the Duke Energy covered high efficiency units. The remaining three dealers were unable to estimate a percent of freeridership. The interview protocol asked each dealer to estimate the percent of their program-covered high efficiency unit sales that would have occurred even if the price they quoted to their customers would not have been discounted via the Duke Energy equipment incentive. The dealers, on average, indicated that between twenty-five and thirty percent of their sales (25%-30%) of the high efficiency units would have occurred without the program. The responses were similar for both air conditioners and heat pumps. However, dealers report slightly different levels of freeridership for heat pumps compared to air conditioners. While these same dealers indicated that all of their sales of high efficiency units were, in some way, influenced by the Duke Energy price reduction, these same dealers put their customer's levels of freeriders, on average, at 25 to 30 percent (average 0.25 for air conditioners and 0.30 for heat pumps).

For the purposes of this study, TecMarket Works sets the program-level freeridership at the mid-point between the values estimated by the interviewed dealers. That value is 27.5%. This may over-estimate the value for air conditioners and underestimate the value for heat pumps. However, because of the limited number of responses these numbers are not statistically different enough to conclude a difference at the technology level. As a result of this estimate, TecMarket Works finds that 72.5% of the units sold were caused by or substantially caused by the Duke Energy program and would not have been sold without the program's influence.

Spillover

The participant survey asked customers if they had taken additional actions to save energy beyond the equipment discounted as a result of the Duke Energy program. Thirty-two (32%) indicated that they had taken additional actions beyond those covered by the program. However, TecMarket Works is not crediting any additional savings to the program as a result of these actions because the customers did not understand that the Duke Energy program was responsible for the reduced price of the program-covered incentive, and because the participating dealers do not push additional products or behavior changes as a result of the Duke Energy program. This finding may change if future interviews with the participating dealers and surveys with customers identify that Duke Energy has in some way caused all or a portion of those actions to occur. This conclusion is supported by the majority of the interviewed dealers who indicated that their customers were not aware of the Duke Energy program at the time of the customer's decision to purchase.

Net to Gross Ratio

The net to gross ratio for this program is set at 0.725 and includes a downward adjustment in gross savings equal to 27.5% of the gross savings. There is no adjustment for spillover savings for this program until such time as the program can be found to be a cause of additional actions being taken by program participants. As a result, the final net-to-gross ratio for the program is set at 0.725.

Appendix A: Estimated Statistical Model

This appendix show the complete model estimated for the billing analysis. The model includes indicators for each month (the YYYYMM variable), temperature, and the participation variables.

kwhyear	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
hp_oh_eng	-1.085192	.0156737	-69.24	0.000	-1.115912	-1.054473
ac_oh_eng	-.5513968	.0463747	-11.89	0.000	-.6422897	-.4605038
hp_cl_eng	-.5602956	.0139649	-40.12	0.000	-.5876664	-.5329248
ac_cl_eng	-.6728898	.0173447	-38.80	0.000	-.7068849	-.6388947
tme#c.atemp						
200901	-913.7671	6.085213	-150.16	0.000	-925.6939	-901.8403
200902	-343.6916	7.26964	-47.28	0.000	-357.9399	-329.4434
200903	-390.8604	12.29096	-31.80	0.000	-414.9503	-366.7706
200904	-271.3217	14.12966	-19.20	0.000	-299.0154	-243.6281
200905	38.25065	13.30942	2.87	0.004	12.16461	64.33668
200906	541.3495	14.65064	36.95	0.000	512.6347	570.0643
200907	-226.1684	15.70453	-14.40	0.000	-256.9488	-195.3881
200908	291.9479	12.93154	22.58	0.000	266.6025	317.2933
200909	422.4782	12.54466	33.68	0.000	397.8911	447.0653
200910	72.02099	8.661937	8.31	0.000	55.04387	88.9981
200911	-182.7167	12.81394	-14.26	0.000	-207.8316	-157.6018
200912	-384.9971	8.653933	-44.49	0.000	-401.9586	-368.0357
201001	-1207.315	9.643819	-125.19	0.000	-1226.216	-1188.413
201002	-236.4453	9.281978	-25.47	0.000	-254.6377	-218.2529
201003	-523.1728	8.899549	-58.79	0.000	-540.6156	-505.73
201004	-272.333	12.62213	-21.58	0.000	-297.072	-247.5941
201005	241.5872	13.89349	17.39	0.000	214.3565	268.818
201006	643.2156	15.28561	42.08	0.000	613.2563	673.1749
201007	632.6885	19.8788	31.83	0.000	593.7267	671.6503
201008	550.5609	20.72206	26.57	0.000	509.9463	591.1755
201009	499.6086	14.61731	34.18	0.000	470.9591	528.258
201010	296.6883	10.38808	28.56	0.000	276.328	317.0486
201011	-179.2051	10.95534	-16.36	0.000	-200.6772	-157.733
201012	-565.9388	8.366704	-67.64	0.000	-582.3373	-549.5403
201101	-673.5651	13.65525	-49.33	0.000	-700.3289	-646.8012
201102	-780.1368	9.999165	-78.02	0.000	-799.7348	-760.5388
201103	-580.2816	11.67736	-49.69	0.000	-603.1689	-557.3944
201104	-296.3959	13.40752	-22.11	0.000	-322.6742	-270.1176
201105	168.4322	16.95744	9.93	0.000	135.1961	201.6682
201106	623.2664	14.92664	41.76	0.000	594.0107	652.5221
tme						
200902	-25705.23	346.5428	-74.18	0.000	-26384.44	-25026.01
200903	-24840.03	588.0499	-42.24	0.000	-25992.59	-23687.47
200904	-32458.36	768.8295	-42.22	0.000	-33965.24	-30951.48
200905	-49999.84	862.4094	-57.98	0.000	-51690.13	-48309.54
200906	-82434.03	1051.236	-78.42	0.000	-84494.41	-80373.64
200907	-22183.3	1180.341	-18.79	0.000	-24496.73	-19869.87
200908	-61815.77	988.7357	-62.52	0.000	-63753.66	-59877.88
200909	-73287.39	933.2411	-78.53	0.000	-75116.51	-71458.26
200910	-51609.09	588.1439	-87.75	0.000	-52761.83	-50456.35
200911	-37437.37	722.1384	-51.84	0.000	-38852.73	-36022
200912	-25245.57	451.6399	-55.90	0.000	-26130.77	-24360.37
201001	9588.784	396.5249	24.18	0.000	8811.608	10365.96
201002	-27710.61	397.4397	-69.72	0.000	-28489.58	-26931.64
201003	-18321.73	432.9353	-42.32	0.000	-19170.26	-17473.19
201004	-31497	750.2375	-41.98	0.000	-32967.44	-30026.56
201005	-62780.79	909.432	-69.03	0.000	-64563.24	-60998.33

201006	-90085.7	1140.603	-78.98	0.000	-92321.24	-87850.15
201007	-88609.74	1575	-56.26	0.000	-91696.69	-85522.79
201008	-82419.24	1669.476	-49.37	0.000	-85691.36	-79147.12
201009	-79675.89	1129.434	-70.55	0.000	-81889.54	-77462.23
201010	-66272.66	731.0191	-90.66	0.000	-67705.43	-64839.88
201011	-36859.49	650.8755	-56.63	0.000	-38135.18	-35583.79
201012	-16006.69	426.1167	-37.56	0.000	-16841.87	-15171.52
201101	-11038.53	516.6781	-21.36	0.000	-12051.2	-10025.86
201102	-7096.302	447.7675	-15.85	0.000	-7973.912	-6218.693
201103	-15183.09	612.8344	-24.78	0.000	-16384.22	-13981.95
201104	-29628.96	765.9756	-38.68	0.000	-31130.25	-28127.67
201105	-57977.34	1106.54	-52.40	0.000	-60146.13	-55808.56
201106	-88967.22	1113.216	-79.92	0.000	-91149.09	-86785.36
_cons	61532.85	243.7272	252.47	0.000	61055.15	62010.54

Appendix B: DSMore Table

Per Measure Impacts Summary for Smart Saver Carolinas

Impacts ⇨ / Technology ⇩	Product code	State	EM&V gross savings (kWh/unit)	EM&V gross kW (customer peak/unit)	EM&V gross kW (coincident peak/unit)	Unit of measure	Combined spillover less freeridership adjustment	EM&V net savings (kWh/unit)	EM&V net kW (customer peak/unit)	EM&V net kW (coincident peak/unit)	EM&V load shape (yes/no)	EUL (whole number)
Air Conditioner		Carolina	830	0.353	N/A	unit	27.50%	602	0.256	N/A	no	18
Heat Pumps		Carolina	997	0.439	N/A	unit	27.50%	723	0.318	N/A	no	18
Program wide			**944**	**0.412**	**N/A**		27.50%	**685**	**0.299**	**N/A**		

Notes: Coincidence factors to be applied in DSMore using the residential HVAC load shape in the DSMore library.

Appendix C: November 23, 2011 Memo to Duke Energy

In using both engineering and billing analysis approaches for this evaluation, it was discovered that there was a marked difference between the engineering analysis and billing analysis in the preliminary results. This difference was due a result of using different participant samples for the engineering and billing analyses, as described in the memo below.

TecMarket Works

**TecMarket Business Center
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Memorandum

To: Ashlie Ossege, Duke Energy
From: Michael Ozog, Integral Analytics
Date: November 23, 2011
Subject: Status of Residential Smart Saver impact evaluation

This memo reviews the status of the impact evaluation of the residential Smart $aver program. The impact evaluation consists of both engineering and a billing data analyses. The engineering analysis consists of DOE-2 simulations of prototypical residential buildings combined with pre-post monitoring of HVAC system fans at a sample of participant sites. The DOE-2 simulations provide unit energy savings estimates (kWh/ton and kW/ton) for central air conditioners and heat pumps at various efficiency levels. Since the program requires electronically commutated (EC) motors on the supply fans of the rebated equipment, pre/post monitoring of HVAC system fans was used to improve the simulation models by observing how participants used this feature in their new systems. The billing analysis uses pre- and post-participation data of participants within a regression model to estimate program impacts.

Both the billing data and engineering analysis were initially completed in September. However, when the results were compared, there was a marked difference between the results from the engineering analysis and the billing analysis. To investigate this difference, the engineering estimates were combined into the regression model in a statistically adjusted engineering (SAE) framework. While constructing the SAE model, it was noted that the samples used for the engineering analysis did not match the sample used in the billing data analysis, with the engineering analysis having significantly fewer participants than the billing analysis.

Therefore, a new extract of the participation data for Smart $aver was conducted in order to insure that both samples were consistent and the SAE model could be run with the full set of program participants. Once this task was completed, new engineering and billing data analyses were conducted. This procedure was, naturally, time consuming, and was not completed until mid-November. The results are currently being reviewed internally and will be available once the internal review is completed.

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Memorandum

To: Ashlie Ossege, Duke Energy
From: TecMarket Works
Date: December 29, 2011
Subject: Evaluated Savings for 3 Lamp High Bay Fixture

This memo provides an update to the evaluated savings for High-Bay fixtures in the Non-Residential Smart $aver® Prescriptive program as implemented in North and South Carolina.

The TecMarket Works evaluation study (dated 6/16/2011) of the Non-residential Smart $aver program as implemented in North and South Carolina included a process evaluation and an impact evaluation of high bay lighting measures. The evaluation report covered High Bay linear fluorescent fixtures with both high output T-5 and standard output (32W) T-8 lamps. The study estimated the following realization rates for high bay fixtures:

State	Realization rate for kWh savings	Realization rate for kW savings
North Carolina	1.77	1.14
South Carolina	1.62	1.02

Since the report was issued, a new fixture type has been introduced into the program. The new fixture is a 3 lamp fixture with standard T-8 lamps. The program planning estimates for this fixture are 0.099 kW savings and 373 kWh savings per year. The program planning estimates were developed by the same company, and utilized the same annual operating hour assumptions as the fixtures covered in the evaluation. The Tecmarket Works team recommends applying the realization rates estimated for high bay fixtures to this new fixture, as shown below:

Parameter	kWh	kW
Program savings estimates	373	0.099
NC realization rate	1.77	1.14
NC evaluated savings	660	0.113
SC realization rate	1.62	1.02
SC evaluated savings	604	0.101
Combined savings	**641**	**0.109**

The combined savings were computed by weighting the NC and SC participation (0.66 and 0.34 respectively), as was done in the evaluation report.

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Memorandum

To: Tom Wiles, Duke Energy
From: TecMarket Works
Date: February 2, 2012
Subject: Carolinas Non-Residential Smart $aver® VFD Impact Results

This memo provides an update to the variable frequency drives (VFD) component of the Non-Residential Smart $aver® Prescriptive program evaluation. Program tracking data obtained from Duke Energy from June, 2009 through May 5, 2011 were analyzed, and the savings by end-use are depicted in Figure 1. Lighting made up over 90% of the projected program savings. Motors, pumps, and drives was the next largest end-use category, comprising about 4.4% of the total. HVAC make up about 3.7% of the total reported savings, while foodservice and other measures make up less than 1% of the savings logged under the program.

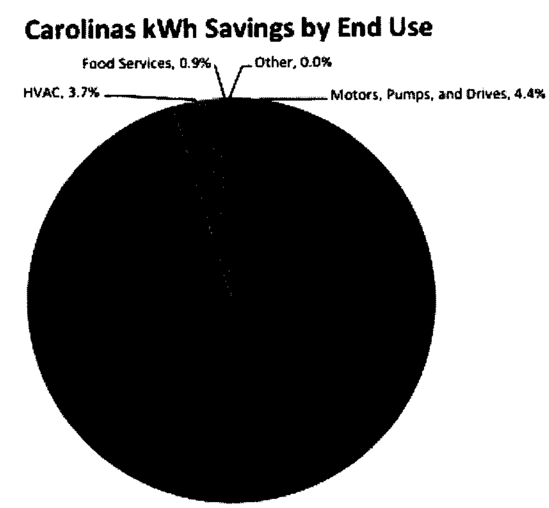

Figure 1. Measure Contribution to the Carolinas Non-Residential Smart $aver Program Savings

Within the lighting category, high-bay fixtures provided the majority (64%) of the savings, with linear fluorescent (14%), CFLs (10%), occupancy sensors (9%), and other measures (3%) making up the remaining lighting savings. Within the motors pumps and drives category, variable frequency drives (VFDs) made up virtually all (99%) of the savings.

Because it was apparent early on in the program cycle that lighting, and particularly high-bay

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lighting fixtures, would dominate the savings from the program, a process and impact evaluation of high-bay lighting was completed and finalized on February 26, 2011. This is consistent with the evaluation plan's stated intention to focus evaluation resources on measures expected to deliver the most impacts. Additional lighting studies addressing linear fluorescents, occupancy sensors, and CFLs are planned for 2012. This memo provides an update to the VFD measure savings, as the second largest evaluation grouping in the prescriptive portfolio.

As stated above, savings were updated using data from the Non-Residential Smart $aver program tracking database through May 5, 2011. By applying tracking data, the team was able to assign each VFD to one of three categories: HVAC fan, HVAC pump, or process. The distribution of the VFD savings across these three categories is shown in Figure 2.

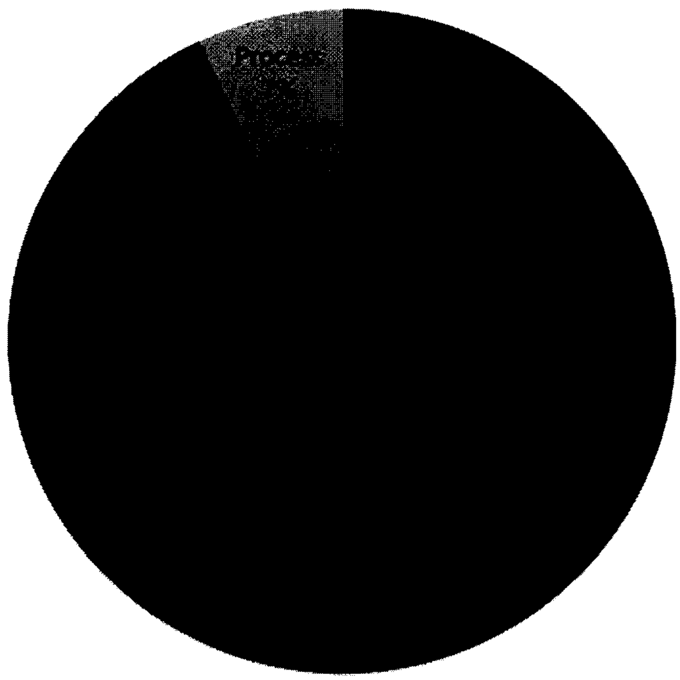

Figure 2. VFD kWh savings distribution

Note, HVAC fans dominate the VFD savings, followed by HVAC pumps and process VFDs. For HVAC fan and HVAC pump measures, the normalized savings (kWh/hp and kW/hp) from the June 2010 update of the Morgan Marketing Partners (MMP) weather-sensitive measure database were applied to each of the measures according to the VFD type, customer building type, and location.

The MMP database contains the results of DOE-2 simulations of measure savings across common residential and commercial building types. The simulation models are based on the California Database for Energy Efficiency Resources (DEER) study, with modifications to adapt these models to local design practices and climate. Models were developed for small commercial buildings (assembly, big-box retail, fast food restaurant, full service restaurant, grocery, light industrial, school, small office, small retail, and warehouse buildings) and large commercial buildings (hospital, hotel, and large office buildings). The large commercial buildings address measures used in built-up HVAC systems, including air cooled and water cooled chillers, chilled water setback control, and variable frequency drives on fans and pumps. The June 2010 update expanded the list of large commercial buildings from a single large office building to include hospitals and hotels along with large offices.

Variable frequency drives on air handlers and pumps were analyzed in the MMP database. The VFD fan applications simulated VFDs applied to both the supply and return fans of the Variable Air Volume (VAV) built up system air handlers in the large office, hospital, and hotel buildings. Inlet vane control was assumed in the base case. VFD pumping applications were simulated by applying a VFD to the secondary loop of a constant volume primary/secondary pumping system. Three-way chilled water coil control valves were assumed in the base case, while the variable flow case assumed two-way control valves.

Annual kWh and summer peak demand savings estimates were developed based on differences between the simulated energy consumption and peak demand at the baseline and the measure efficiency levels. The set of simulations described above were conducted for Asheville, NC; Charlotte, NC; and Greenville, SC using long term average weather data.[1] The results of these simulations were compiled into a database containing measure savings and measure costs by building type. Results of the VFD measure simulations are shown in Table 1.

Table 1. Unit Energy and Demand Savings from MMP Database

Measure	Building Type	Climate	Units	kWh/ unit	Summer kW/unit
HVAC Pump	Hospital	Charlotte	per CHW pump hp	5,281	0.530
HVAC Pump	Hospital	Asheville	per CHW pump hp	5,271	0.487
HVAC Pump	Hospital	Greenville	per CHW pump hp	5,267	0.518
HVAC Pump	Large Office	Greenville	per CHW pump hp	2,741	0.309
HVAC Pump	Large Office	Asheville	per CHW pump hp	2,643	0.199
HVAC Pump	Large Office	Charlotte	per CHW pump hp	2,547	0.298
HVAC Pump	Hotel	Greenville	per CHW pump hp	2,380	0.088
HVAC Pump	Hotel	Asheville	per CHW pump hp	2,280	0.095
HVAC Pump	Hotel	Charlotte	per CHW pump hp	2,260	0.088
HVAC Fan	Hospital	Charlotte	per fan hp	1,676	0.176
HVAC Fan	Hospital	Greenville	per fan hp	1,651	0.153
HVAC Fan	Hospital	Asheville	per fan hp	1,545	0.111
HVAC Fan	Large Office	Charlotte	per fan hp	1,374	0.132
HVAC Fan	Large Office	Greenville	per fan hp	1,267	0.174

[1] The Typical Meteorological Year Version 3 (TMY3) weather data set from the National Renewable Energy Laboratory (NREL) was used.

Measure	Building Type	Climate	Units	kWh/ unit	Summer kW/unit
HVAC Fan	Large Office	Asheville	per fan hp	1,149	0.018
HVAC Fan	Hotel	Charlotte	per fan hp	933	0.208
HVAC Fan	Hotel	Greenville	per fan hp	871	0.209
HVAC Fan	Hotel	Asheville	per fan hp	821	0.204

Customer building types from the tracking data were then mapped into one of the three building type categories in the MMP database that address VFDs: Office, Hospital, or Hotel. The customer location was then in turn mapped into one of the three cities in the MMP database: Charlotte, Asheville, or Greenville.

The program planning estimates were based on an earlier version of the database that contained the office building type only, and were based on results for HVAC pumps in Asheville and Charlotte only. Reweighting the impacts in this manner allows for a more accurate estimation that accounts for actual deployed use, type, and location. VFDs applied to process equipment were assigned the appropriate value from the Franklin Energy Systems (FES) work-papers on process VFDs.

The savings were summed over each of the VFD measures in the program tracking database. A participation weighted average savings value per VFD was calculated for each of the VFD size and type categories used in the DSMore runs. The results of this analysis that considers application type, participation, location, and building type are shown in Table 2.

Table 2. VFD kWh and kW Savings by Size and Type

HP \ Type	HVAC		Process	
	kWh/VFD	kW/VFD	kWh/VFD	kW/VFD
1.5	1,787	0.26	1,436	0.39
2	2,401	0.36	1,914	0.52
3	3,834	0.51	2,871	0.78
4	6,181	0.45	3,828	1.04
5	6,747	0.81	4,785	1.30
7.5	10,129	1.14	7,178	1.95
10	14,541	1.80	9,570	2.60
15	24,856	2.82	14,355	3.90
20	40,819	4.63	19,140	5.20
25	41,370	4.31	23,925	6.50
30	49,497	5.26	28,710	7.80
40	66,577	5.05	38,280	10.40
50	79,738	8.70	47,850	13.00

The original estimates assumed all HVAC applications were VFD pumps, however most of the applications were HVAC fans, which carry a lower savings value. Consequently, the savings per VFD were generally reduced by this analysis. A comparison of the savings per VFD from the original estimates and this analysis is shown in Figure 3.

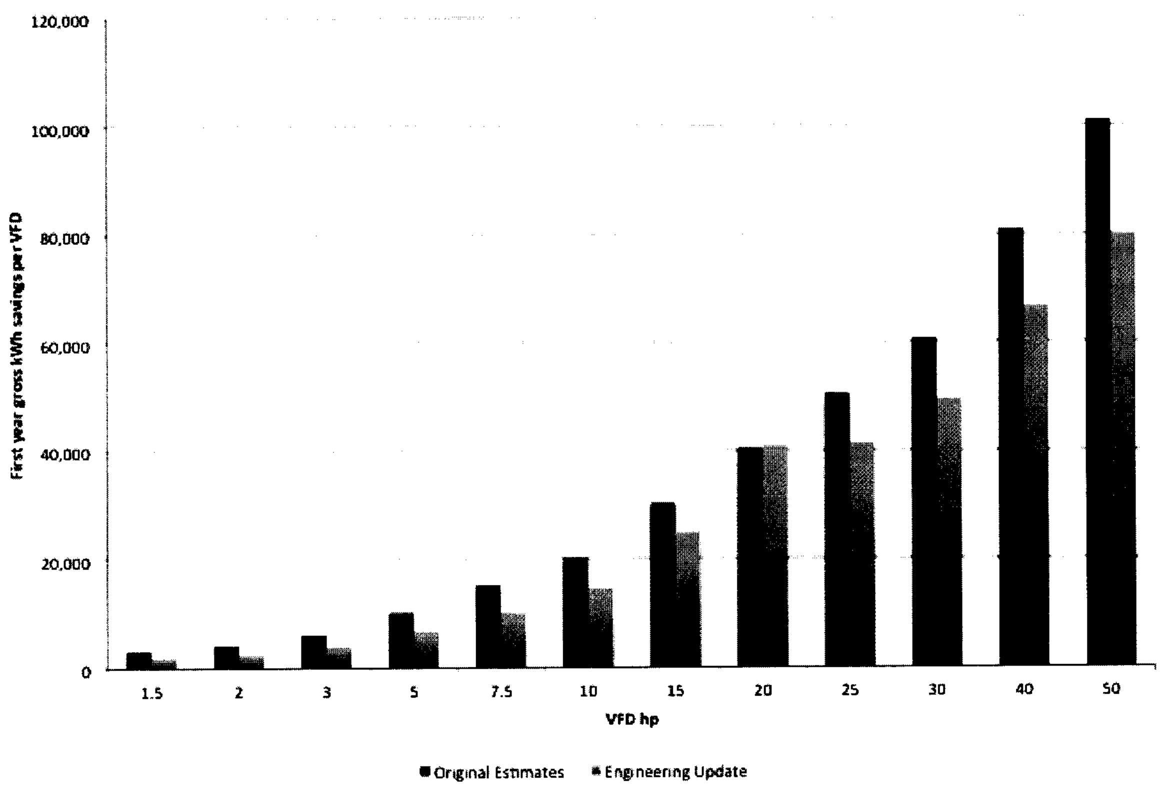

Figure 3. Comparison of Original Estimates with Updated Engineering Estimates

The average savings normalized per VFD hp was computed for each of the VFD types, as shown in Table 3.

Table 3. Average Normalized VFD Savings

VFD Type	Average kWh/hp	Average kW/hp
HVAC Fan	1374	0.160
HVAC Pump	2774	0.305
Process	957	0.260

The original savings were normalized per hp and compared to the updated engineering estimates. The process VFD savings decreased slightly, from a range of 1071 to 1082 kWh/hp (depending on VFD size) to 957 kWh/hp. The HVAC VFD savings went from 2021 kWh/hp (for all HVAC applications) to 2774 kWh/hp per HVAC pump and 1374 kWh/hp per HVAC fan.

Recommendations

1. Since the HVAC fan and pump savings estimates vary widely, future estimates should assign a separate value for fans and pumps.
2. The contribution of VFDs to the Non-Residential Smart $aver program savings is small, but should be tracked over time. If VFDs become a more significant portion of the portfolio, additional analysis of measure savings should be done to refine the engineering estimates.
3. The diversity of building types that have installed VFDs exceeds the current set of three building types. Consider expanding the list of building types to include additional

building types such as education, industrial, and retail building types in future updates of the engineering estimates.